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Influences on the Timing and Frequency of Cancellations and Truncations of Major Defense Acquisition Programs

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David L. McNicol

Executive Summary

IDA Paper P-5218[1] examined whether changes in acquisition policy and funding climate had statistically discernible associations with cancellations of Major Defense Acquisition Programs (MDAPs). Data on reductions of the number of units purchased—that is, truncations—of programs that passed Milestone (MS) B post fiscal year (FY) 1988 also were presented, but not examined statistically. This paper significantly extends IDA P-5218. It provides parallel analyses of both cancellations and truncations, has more observations (especially on truncations), and provides an improved statistical analysis of cancellations.

Brief Census of Cancellations and Truncations

The paper begins with a brief review of the frequency of cancellations and truncations, which is not part of the common knowledge of the acquisition community. The database used contains 312 MDAPs that entered Engineering and Management Development (EMD) during FY 1965–FY 2009. (MS II, which is now designated MS B, was not established until 1969.) Of these, 58 were cancelled. (See table below.) The cancellation rate for Joint Programs (26 percent) is somewhat higher than the average for Service-managed programs (about 17 percent). The Department of the Navy has the lowest cancellation rate (14 percent) and the Army the highest (23 percent). These differences are not statistically significant, however. Data presented in the main text indicate that a little more than one-third of cancellations apparently were initiated by a Military Department.

Cancellations, Total Programs, and Cancellation Rate by Military Department and Joint Programs

	No. of Cancellations	No. of Programs	Cancellation Rate
Army	18	77	23%
Navy	15	110	14%
Air Force	13	79	16%
Joint	12	46	26%
Total	**58**	**312**	**19%**

[1] David L. McNicol, Sarah K. Burns, and Linda Wu, "Evidence on the Effect of DoD Acquisition Policy and Process and Funding Climate on Cancellations of Major Defense Acquisition Programs," IDA Paper P-5218 (Alexandria, VA: Institute for Defense Analyses, May 2015).

We also computed completion ratios (i.e., the fraction of the MS B baseline quantity that was actually bought) for 162 completed MDAPs. The median program completed 100 percent and the average program completed 118 percent of the MS B baseline quantity. About 60 percent of the MDAPs in the sample completed at least 90 percent of their MS B baseline quantity. These figures are somewhat higher than is commonly appreciated and serve to limit the extent to which truncations reasonably can be viewed as a major problem. Twenty-four MDAPs—about one in seven of the total sample—completed less than 50 percent of their MS B baseline quantity, however. Some of these would fit comfortably on a list of cancelled programs but others would not. The F-22, for example, acquired only 29 percent of its MS B quantity and the F-14D only 18 percent. In short, there does not seem to be any clear line that separates truncations that are essentially cancellations from those that are not.

Acquisition Policy and Process, Cancellations, and Truncations

This paper recognizes five acquisition policy and process configurations and two funding climates—bust and boom. One of the two central questions of the paper is whether, for a given funding climate, the odds that an MDAP will eventual be cancelled or substantially truncated differ significantly depending on the acquisition process and policy in effect when it passed MS B.[2]

A significantly higher proportion of the MDAPs that passed MS B during FY 1987–FY 1989 were cancelled. This appears to be explained primarily by unique historical factors, however, rather than by features of the acquisition policy and process in place at that time—in particular, the attempt of the Reagan Administration to maintain defense procurement at a high level. While FY 1987–FY 1989 may be a partial exception, generally there was no statistical association of the frequency of cancellations and acquisition policy and process within either bust or boom climates. Similarly, the odds that a program acquired less than 75 percent of its MS B baseline quantity were not associated with the acquisition policy and processes and funding climate when it passed MS B.

The odd thing about these results is the absence of any reduction in cancellations or increase in completion ratios associated with the Packard reforms instituted in mid-1969. Loosely, unit cost growth went down when the Packard reforms were instituted and stayed down until the Acquisition Reform period (FY 1994–FY 2000); cancellation rates

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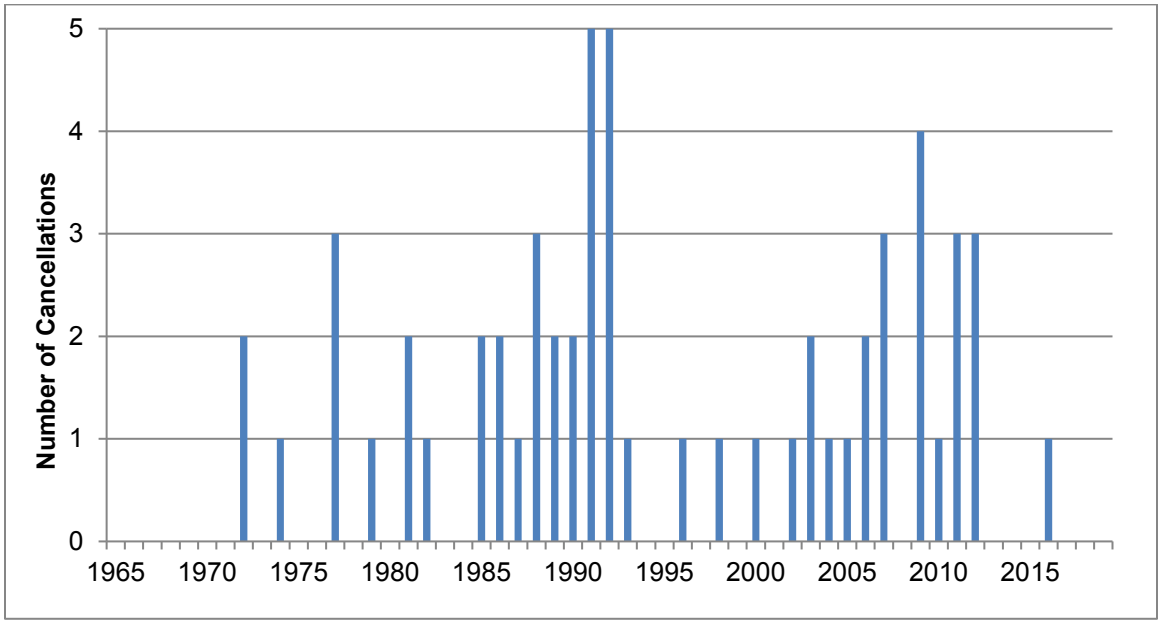
[2] P-5330 (Revised) found that there were two periods (FY 1965–FY 1969 and FY 2004–FY 2009) during which average unit cost growth was significantly higher than in other periods. David L. McNicol et al., "Further Evidence on the Effect of Acquisition Policy on Cost Growth of Major Defense Acquisition Programs," IDA Paper P-5330 (Revised) (Alexandria, VA: Institute for Defense Analyses, August 2016).

did not. This is odd because on the face of the matter similar factors govern unit cost growth as govern the likelihood of cancellation. One possible resolution of this apparent dilemma is that some "good" programs have "bad" (that is, unreasonably optimistic) cost estimates. Another possibility is that many cancellations are associated with funding declines, not program failures.

Funding Climate, Cancellations, and Truncations

The second major question considered in this paper is whether cancellations and truncations are associated with funding climate, for a given acquisition policy and process configuration.

Neither cancellations nor truncations proved to be statistically associated with the funding climate that prevailed when programs passed MS B. Cancellations were, however, associated with periods of sharp declines in Department of Defense (DoD) procurement funding. The figure below shows the number of MDAPs cancelled in each fiscal year over the period FY 1965–FY 2016. Two clusters of cancellations are evident. The first of these, FY 1986–FY 1994, was the start of the bust phase following the Carter-Reagan boom. From peak procurement Budget Authority of $183.9 billion (FY 2017 dollars) in FY 1985, procurement fell to $64.8 billion in FY 1994, about 35 percent of its FY 1985 level. The second period of declining funding was FY 2009–FY 2013. FY 2013 DoD procurement funding in constant 2017 dollars stood at about 55 percent of its FY 2008 level.



Number of MDAPs Cancelled Each Year, FY 1965–FY 2016

Twenty-one MDAPs were cancelled during FY 1986–FY 1994 and 11 were cancelled during FY 2009–FY 2013. During the 14 years of these two periods taken together, 32 MDAPs were cancelled, an average of nearly 2.3 cancellations each year. During the other 38 years, on average, about two MDAPs were cancelled every three years (for a total of 26). A simple model was used to compute the probabilities of the observed cancellations for the two periods of declining procurement funding. Using that model, the probability of observing 21 or more cancellations during the nine years of FY 1986–FY 1994 is 0.003. The corresponding probability of observing 11 or more cancellations for the FY 2009–FY 2013 period was 0.04. In contrast, truncations (to less than 75 percent of the MS B baseline quantity) did not show a tendency to cluster in periods of sharply decreasing procurement funding.

Cost Growth and Cancellations and Truncations

Finally, the paper takes up the conventional wisdom connecting high cost growth to MDAP cancellations. Program Acquisition Unit Cost (PAUC) includes both Research, Development, Test, and Evaluation (RDT&E) and procurement cost, and probably is the relevant measure of unit cost in the context of cancellations. The MS B baseline value for PAUC can be thought of as a goal or a prediction. PAUC growth is computed by comparing baseline value to the actual PAUC reported in the program's last Selected Acquisition Report (SAR). Both the MS B PAUC and that from the final SAR are stated in constant dollars. In addition, the PAUC from the final SAR is normalized to the MS B quantity. In what follows, "quantity normalized PAUC growth" will be abbreviated to simply "PAUC growth." For the purposes of this paper, high unit cost growth is arbitrarily defined as PAUC growth against the MS B baseline of at least 50 percent.

The database used in this research contains an estimate of PAUC for 156 completed MDAPs. Of these, 43 had PAUC growth of at least 50 percent. The average PAUC growth of these programs was 93 percent, and PAUC at least doubled for 9 of the 43. Clearly, then, not all MDAPs with high cost growth were cancelled.

Furthermore, from the limited information available, it does not appear that all MDAPs that were cancelled had high unit cost growth. It proved to be possible to get an estimate of the amount of PAUC growth that occurred prior to cancellation for 25 of the 58 cancelled MDAPs. Only 10 of those 25 cancelled programs showed high cost growth. Another 10 had PAUC growth of between zero and 30 percent, and five showed negative PAUC growth. The conclusion from these estimates then, clearly, would be that not all cancelled programs had high cost growth. The PAUC growth estimates, unfortunately, understate the true PAUC growth for cancelled programs in that they do not capture the cost growth between the date of the SAR used and the termination of the program. In addition, there tends to be some delay in reporting cost growth that can be expected to

occur based on the evidence to date but which has not yet in fact materialized. The PAUC growth estimates for the 25 programs, then, are indicative but not conclusive.

Conclusions

The clearest conclusion offered by this paper is that cancellations of MDAPs are concentrated in the two periods during which DoD procurement funding was declining, often sharply. This is not a surprising conclusion, but it is useful to know that cancellation of major programs is in fact one of the ways that DoD responded to large funding reductions. Truncations, in contrast, were not clustered in periods of declining procurement funding, which is surprising.

Apart from the association of cancellations and decreases in procurement funding, the conclusions offered are about what appears not to matter—or to matter much—in cancellation and truncation decisions:

- Possibly with the partial exception of FY 1987–FY 1989, within a funding climate there is no statistical association between cancellations or completion ratios of less than 75 percent and the acquisition policy and process prevailing when a program passes MS B.
- Second, given acquisition policy and process configuration, there is no statistical association between funding climate at MS B and cancellations or completion ratios of less than 75 percent.
- Third, while cancelled programs on average had higher cost growth than programs not cancelled, most programs with PAUC growth of more than 50 percent were not cancelled. Clearly, there is more behind cancellations than cost growth. The evidence does not permit a similar conclusion for truncations, although it permits those so inclined to accept that higher PAUC growth tends to result in lower completion rates.

Is it reasonable to infer from these conclusions that large decreases in DoD funding such as those of FY 1986–FY 1993 and FY 2009–FY 2013 caused the cancellation of MDAPs that otherwise would have been completed? To be clear about this, it is necessary to distinguish between decisions to reduce the overall DoD acquisition portfolio and decisions about which programs to cancel. The latter involve a range of considerations—how well the programs are doing, how important they are, and the continued salience of the threats to which they respond, among others. The decision on the extent to which cancellations should be used to close a funding gap involves choices among bad alternatives—cancellations, delays in new starts, stretches of existing programs, acceptance of less capable alternatives in some cases, and adoption of very optimistic costing and programmatic decisions for both new starts and—to the extent possible—ongoing programs. Viewed from this angle, the root cause of many

cancellations seems to be a mismatch between DoD's missions and functions, its force structure, and its funding.

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Supporting data files provided on CD (inside back cover):

- Main Database V 5.3.xlsx
- Program Notes.docx
- Data and Computations for In-house Cost Growth Estimates.xlsx
- IDA Paper P-2722-VOL-1.pdf
- IDA Paper P-2722 Vol 1_Main Report Appendix A Tables 1-10.xlsx
- McCrillis Briefing.pdf

A. Introduction

IDA Paper P-5218[1] examined whether changes in acquisition policy and funding climate had statistically discernible associations with cancellations of Major Defense Acquisition Programs (MDAPs). Data on reductions of the number of units purchased of programs that passed Milestone (MS) B post fiscal year (FY) 1988 also were presented, but not examined statistically. This paper significantly extends IDA P-5218; it provides parallel analyses of both cancellations and truncations, has more observations (especially on truncations), and uses different statistical methods in the analysis of cancellations.

Sections C through E examine these questions in turn:

- Is there a statistical association between changes in acquisition policy and process (given funding climate) and the frequency of cancellations and truncations?
- Are changes in Department of Defense (DoD) procurement funding associated with cancellations and truncations (given acquisition policy and process)?
- Is very high cost growth a major cause of most cancellations and truncations?

Readers who are inclined to believe that cost growth is a dominant factor in cancellations may wish to start with Section E. Those who have read any of the earlier papers in this series probably will be more at home reading the sections in the order stated.

A brief survey of cancellations and truncations of MDAPs is provided in Section B. Conclusions reached are summarized in Section F.

B. Brief Census of Cancellations and Truncations

The database used for this research contains 312 MDAPs that entered Engineering and Management Development (EMD) during FY 1965–FY 2009. An MDAP was classified as cancelled if:

- The program did not result in production of any fully configured end items, or
- Any fully configured end items produced were used only for testing and development.

Application of this definition was not clear-cut for six programs that passed MS B at the Service level, later filed Selected Acquisition Reports (SARs), and subsequently were cancelled. The five that had been designated as an Acquisition Category I (ACAT I)

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[1] David L. McNicol, Sarah K. Burns, and Linda Wu, "Evidence on the Effect of DoD Acquisition Policy and Process and Funding Climate on Cancellations of Major Defense Acquisition Programs," IDA Paper P-5218 (Alexandria, VA: Institute for Defense Analyses, May 2015).

program were included in the database as cancelled programs and the one that had not become an ACAT I program was excluded.[2] In addition, four MDAPs that fit the definition more closely than not were counted as cancelled.[3] Altogether, 58 of the 312 that entered EMD during FY 1965–FY 2009 were classified as cancelled.

Twelve programs that filed at least one SAR during the period FY 1965–FY 2015 but were not designated as ACAT I and/or did not pass MS B also were cancelled. These programs are not in the database or included in the list of cancelled programs. They are, however, listed as numbers 59–70 in the "Programs Notes" file on the compact disc (CD) provided in a pocket on the inside back cover of this paper.

Table 1 presents data on cancellations. The cancellation rate for Joint Programs (26 percent) is somewhat higher than the average for Service-managed programs (about 17 percent). The Department of the Navy has the lowest cancellation rate (14 percent) and the Army the highest (23 percent). These differences are not statistically significant, however.[4]

Table 1. Cancellations, Total Programs, and Cancellation Ratios by Military Department and Joint Programs

	No. of Cancellations	No. of Programs	Cancellation Rate
Army	18	77	23%
Navy	15	110	14%
Air Force	13	79	16%
Joint	12	46	26%
Total	**58**	**312**	**19%**

The final SAR for an MDAP that has been cancelled usually identifies (with varying degrees of clarity) who initiated the cancellation. For example: "President Bush ordered the termination of [SRAM II] on 27 Sept. [19]91."[5] An example from the "less clear" end of the scale is provided by the Joint Ground Launched Tacit Rainbow. The final SAR for the program states that its funding was not included in the "FY92–FY93 President's

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2 AN/WQR-Advanced Deployable System, AQM-127A Supersonic Low Altitude Target, Advanced Seal Delivery System, ASM-135A Air-Launched Anti-Satellite System, and Land Warrior. Extended Range Munition was cancelled before it was designated an ACAT I program.

3 Roland, Safeguard, WIN-T Inc. 3, and C-27J. Brief sketches of the relevant facts are provided in the Program Notes on the CD included with this paper.

4 Chi-square, P = 0.179.

5 SAR for SRAM II, December 31, 1991, 7.

Budget" and that the program was cancelled by the Secretary of Defense.[6] Using such statements from the SARs supplemented by materials found on limited searches on the internet, the initiative for each cancellation was attributed to a Military Department (MilDep), Office of the Secretary of Defense (OSD), the White House, or the Congress. In those cases in which there was no evidence that the cancellation was initiated by the Congress, the White House, or one of the MilDeps, responsibility was assigned to OSD.

The results are reported in Table 2. It is worth noting that a little more than one-third of cancellations apparently were initiated by MilDeps. A cancellation, however, may actually be initiated by an organization other than the one formally responsible for it. There are cases in which, for example, a MilDep cancels a program because it appears to be highly likely that if it does not do so, OSD or the Congress will—in which case, OSD or the Congress probably will decide how to reallocate the funding.

Table 2. Number and Proportion of Cancellations Initiated by Different Levels of Government

Government Entity	No. of Cancellations	Proportion of Cancellations
Military Department	21	36%
OSD	23	40%
White House	4	7%
Congress	10	17%
Total	**58**	**100%**

The definition of cancellation used here ensures that all cancelled programs were in EMD or in the early stages of Low Rate Initial Production (LRIP).[7] In fact, all but 12 were in EMD and only one, the C-27J, was in Full Rate Production. The average time from MS B to cancellation was 5.5 years, and half of all cancellations occurred when the program was no more than 4.8 years beyond MS B, as shown in Figure 1. The distribution has a fairly long tail, however. One program was cancelled over 19 years after it passed MS B and two others were cancelled after more than 12 years.

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6 SAR for the BGM-136 Joint Ground Launched (JGL) Tacit Rainbow, December 31, 1990, 4.

7 Reforms of the DoD acquisition system introduced by David Packard, the Deputy Secretary of Defense, in early FY 1970 established MSs I, II, and III for an MDAP. MS II approval authorized a program to enter EMD; MS IIIA authorized LRIP. A revision of DoD Instruction (DoDI) 5000.2, issued October 23, 2000, formally replaced MSs I, II, and III with MSs A, B, and C. The definitions are such that MS B is placed several months earlier in the process than MS II.

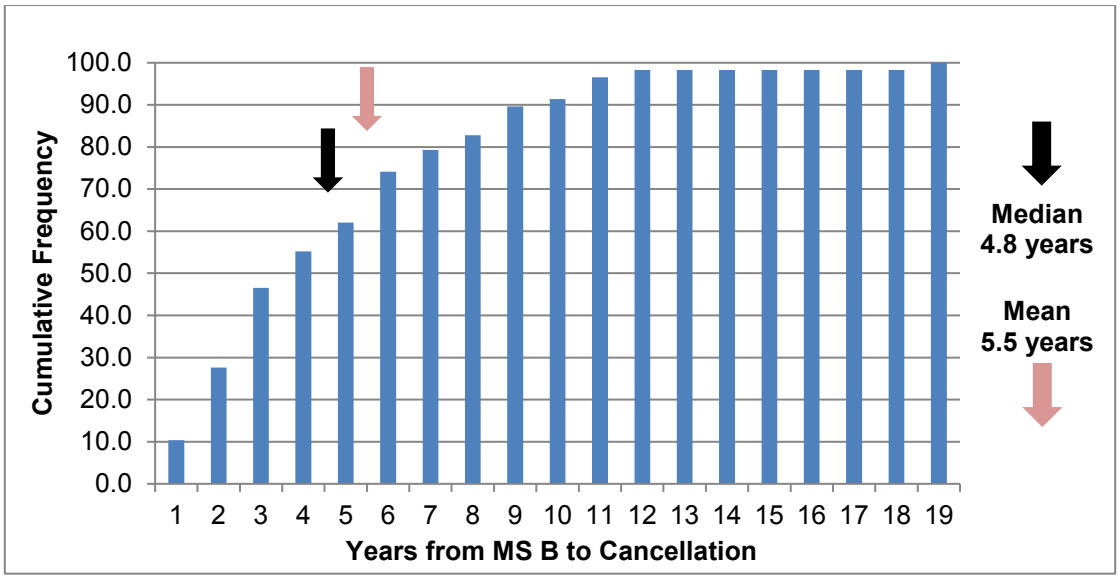

Figure 1. Cumulative Distribution of Time between MS B and Cancellation

The discussion now turns from cancellations to truncations. In most cases, the MS B baseline includes a statement of the total number of fully configured end items to be acquired. The final SAR for a program should report the total number of units actually acquired. Because programs that acquire more than the MS B baseline quantity have a negative truncation ratio it usually is preferable to refer to completion ratios. The completion ratio for a program is simply the total number of end items acquired divided by the anticipated number in the MS B baseline.[8]

The extent to which a program has acquired less or more of its MS B baseline quantity can be gauged reliably only after the program has ended because the size of the planned buy can be cut one year, the cut restored the next year, and the quantity increased beyond the MS B baseline the year after that. For this reason the completion ratios used in the analysis are for completed programs only.

The database used in this paper contains the MS B baseline quantity and the quantity actually acquired for 162 completed MDAPs that began EMD during the period FY 1965–FY 2009. Figure 2 is a histogram of the percentage of the respective MS B quantities acquired by these programs. The median program acquired 100 percent and the average program acquired 118 percent of the MS B baseline quantity. About 60 percent of the MDAPs in the sample acquired at least 90 percent of their MS B baseline quantity.

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[8] The total number of units acquired includes both those purchased with procurement funds and those purchased with Research, Development, Test, and Evaluation (RDT&E) funds. Some art may be required to define the units in which to state the number of fully configured end items acquired.

These figures are somewhat higher than is commonly appreciated and serve to limit the extent to which truncations reasonably can be viewed as a major problem.

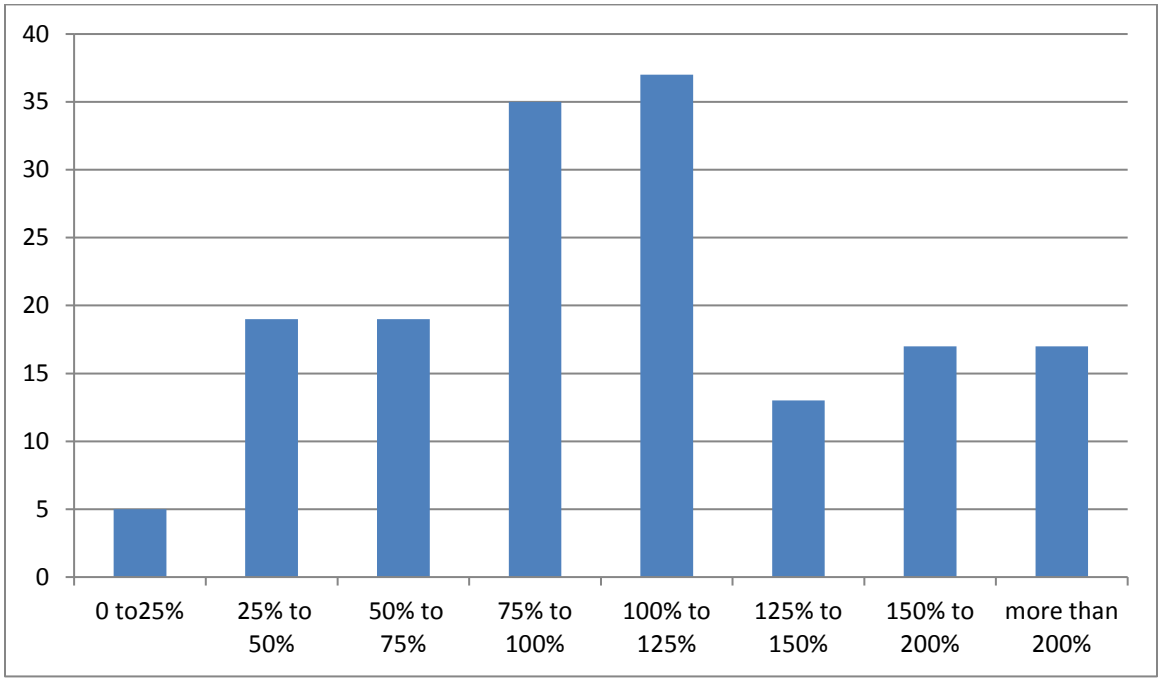

Figure 2. Histogram of the Percentage of the MS B Baseline Quantity Acquired by 162 Completed MDAPs that Passed MS B FY 1965–FY 2009

Twenty-four of the 162 completed programs (about one in seven) acquired less than 50 percent of their MS B baseline quantity. Some of these would fit comfortably on a list of cancelled programs but others would not. The F-22, for example, acquired only 29 percent of its MS B quantity, and the F-14D, only 18 percent. In short, there does not seem to be any line that separates truncations into those that are essentially cancellations and those that are not.

C. Acquisition Policy and Process, Cancellations, and Truncations

This section turns to the question of whether, having approximately normalized for funding climate, changes in acquisition policy and process configuration are statistically associated with cancellations and completion ratios.

The following acquisition policy and process configurations are used in binning the data for statistical analyses:

- McNamara-Clifford, FY 1964–FY 1969;
- Defense Systems Acquisition Review Council (DSARC), FY 1970–FY 1982;
- Post Carlucci DSARC (P-C DSARC), FY 1983–FY 1989;

- Defense Acquisition Board (DAB), FY 1990–FY 1993 and FY 2001–FY 2009;
- Acquisition Reform (AR), FY 1994–FY 2000.

Two funding climates also are distinguished—bust and boom. The acquisition configurations and funding climates are described in Appendix A. Readers who have read previous papers in this series or who are generally familiar with the OSD-level acquisition process and various acquisition reform efforts can use Appendix A selectively. Others may wish to read it before proceeding with the main text.

P-5330 (Revised)[9] offered three conclusions about the association of changes in acquisition policy and process and growth in unit cost[10] for MDAPs that passed MS B in bust funding climates:

1. The Packard reforms introduced in mid-1969 (DSARC) are associated with a statistically significant and persistent reduction in quantity normalized Average Procurement Unit Cost (APUC) growth (hereafter APUC growth).
2. The Carlucci Initiatives (P-C DSARC) and the statutory changes associated with the Packard Commission Report (1986) and the Goldwater-Nicholls Act evidentially did not result in any further reduction in APUC growth (DAB, FY 1990–FY 1993, FY 2001–FY 2009).
3. Compared to other periods, average APUC growth was significantly higher for MDAPs that began development during McNamara-Clifford and the AR period.

Three of the five configurations also were in place during boom funding climates, but none had significantly higher or lower average levels of APUC growth in them.

Cancellations and low completion ratios would be expected to show similar patterns based on the hypothesis that their root causes overlap substantially with those of cost growth. If the expected patterns do appear, our understanding of cost growth in MDAPs is reinforced. A failure of the expected patterns to appear, however, would tend to call into question our understanding of the causes of cost growth.

Table 3 provides data on the number of cancellations and cohort size arrayed by acquisition configuration and funding climate. The third column reports the number of cancellations and cohort size; for example, the database contains 24 MDAPs that entered what is now called EMD during the McNamara-Clifford period, of which three were

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9 David L. McNicol et al., "Further Evidence on the Effect of Acquisition Policy on Cost Growth of Major Defense Acquisition Programs," IDA Paper P-5330 (Revised) (Alexandria, VA: Institute for Defense Analyses, August 2016).

10 Appendix B provides a detailed description of how the quantity normalized APUC growth estimates were made.

cancelled. The next column gives the probability of observing that many cancellations or more, on the assumption that cancellations are independently and identically distributed in each of the periods. A sufficiently low probability leads to the rejection of that assumption for the bin in question. The logic here is that of a coin-flipping trial: if heads comes up too often, we reject the initial presumption that the coin is consistent from one period to the next and conclude that it has changed. The last column gives the probability of observing the actual number of cancellations or fewer assuming consistency, which provides the same check for apparently low cancellation frequencies as the preceding column does for apparently high ones.

Table 3. Cohort Size, Number of Cancellations, and Estimated Probability of the Number of Cancellations by Acquisition Configuration for Completed MDAPs

Period	Fiscal Years	Cancellations k	Probability x ≥ k	Probability x ≤ k
Bust Funding Climates				
McNamara-Clifford	1965–1969	12.5% (3 of 24)	0.845	0.332
DSARC	1970–1980	15.1% (11 of 73)	0.810	0.287
P-C DSARC	1987–1989	40.7% (11 of 27)	0.006*	0.998
DAB	1990–1993 2001–2002	12.9% (6 of 31)	0.518	0.659
AR	1994–2000	13.0% (6 of 46)	0.874	0.233
Boom Funding Climates				
DSARC	1981–1982	22.2% (4 of 18)	0.451	0.757
P-C DSARC	1983–1986	10.0% (5 of 50)	0.971	0.070
DAB	2003–2009	27.9% (12 of 43)	0.098	0.950

Note: Probabilities were computed using the binomial distribution, assuming the average cancellation rate across constellations for the given funding climate.

* Significant at less than the 10 percent level when adjusted for the number of comparisons made.

Each of the five acquisition policy and process configurations was in place during a bust climate. The average cancellation rate across all of the bust climates was 18.4 percent (37 of 201 programs). Only the P-C DSARC had a cancellation frequency significantly above or below the average.[11] After correction for the number of comparisons made, the cancellation frequencies for none of the three acquisition policy

[11] Ten outcomes are evaluated for the bust climates. There is a more than 10 percent chance that at least one of these would by chance appear to be statistically different from the population mean even if the true mean of each of the bins were the population mean. The Bonferroni Correction provides a conservative adjustment of the critical value in such situations. In particular, when 10 comparisons are made, an upper limit for the critical value after the Bonferroni Correction for significance at the 10 percent level is 0.010; i.e., 0.10 divided by 10.

and process configurations that operated in boom climates was significantly different from the boom climates mean (18.9 percent). Overall, apart from the P-C DSARC period, the funding climate prevailing at MS B was not associated with the odds that a program would eventually be cancelled.

Table 4 provides data for completion ratios that parallel those on cancellations in Table 3. The line was drawn at a completion ratio of 75 percent. After adjusting for the number of comparisons, the average completion rate for none of the bins differed significantly from the climate period average. The results for completion ratios are then consistent with those for cancellations; that is, the odds that a program will acquire less than 75 percent of its MS B baseline quantity are not associated with the acquisition policy and process and funding climate when it passed MS B.

Table 4. Cohort Size, Number of Programs with a Completion Ratio of Less than 75 Percent, and Estimated Probability of the Completion Ratio for Completed MDAPs

Period	Fiscal Years	Completion k	Probability x ≥ k	Probability x ≤ k
Bust Funding Climates				
McNamara-Clifford	1965–1969	30.0% (6 of 20)	0.436	0.743
DSARC	1970–1980	28.1% (10 of 48)	0.848	0.248
PC DSARC	1987–1989	53.9% (7 of 13)	0.032	0.992
DAB	1990–1993 2000–2001	31.3% (5 of 16)	0.417	0.775
AR	1994–2000	11.8% (2 of 17)	0.961	0.136
Boom Funding Climates				
DSARC	1981–1982	42.9% (3 of 7)	0.244	0.929
PC DSARC	1983–1986	28.6% (8 of 28)	0.400	0.750
DAB	2003–2009	7.6% (1 of 13)	0.976	0.127

Note: Probabilities were computed using the binomial distribution assuming the average cancellation rate across constellations for the given funding climate.

The odd thing about this result and the corresponding result on cancellations is the absence of any reduction in cancellations or increase in completion ratios associated with the Packard reforms. Loosely, unit cost growth went down when the Packard reforms were instituted and stayed down; cancellation rates did not. This is odd because, as noted earlier, on the face of the matter similar factors govern unit cost growth as govern the likelihood of cancellation. Unreasonably ambitious performance goals established at MS B, in particular, are likely to result in schedule slips, cost growth, and performance shortfalls. Even though the key factor in a decision to cancel may be technical failure, we would expect such failures to be associated with cost growth and schedule slips.

One possible resolution of this apparent dilemma is that some "good" programs have "bad" cost estimates. Another possibility, discussed in the following section, is that many cancellations are associated with funding declines, not program failures.

D. Funding Climate, Cancellations, and Truncations

This section takes up the question of whether, given an acquisition policy and process configuration, funding climate is statistically associated with cancellations and completion ratios. This question is motivated by the significant statistical association between quantity normalized Program Acquisition Unit Cost (PAUC) growth and the funding climate that prevailed at MS B.[12]

By way of background, relevant data on quantity normalized PAUC growth (hereafter PAUC growth) are presented in Table 5. (See page 16 and Appendix B for a description of how PAUC growth was computed.) Three of the five acquisition policy and process configurations were in place in both bust and boom funding climates. These provide a natural "with and without" experiment on the effect of funding climate given acquisition policy and process configuration. Average PAUC growth is significantly higher in each of the acquisition policy and process configurations for programs that passed MS B in a bust funding climate. Note that three programs were excluded from the data for the boom portion of P-C DSARC—T-45, JSTARS, and C-17—because their relatively high cost growth probably is mainly due to the nature of the contracts used to acquire them.[13] If, instead, these three programs are included, the average PAUC growth for programs that passed MS B during the boom portion of P-C DSARC is 20 percent, which is noticeably but not statistically smaller than the average for programs that passed MS B during the bust portion of P-C DSARC (34 percent).

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[12] David L. McNicol and Linda Wu, "Evidence on the Effect of DoD Acquisition Policy and Process on Cost Growth of Major Defense Acquisition Programs," IDA Paper P-5126 (Alexandria, VA: Institute for Defense Analyses, September 2014).

[13] David L. McNicol, "Post-Milestone B Funding Climate and Cost Growth in Major Defense Acquisition Programs," IDA Paper P-8091 (Alexandria, VA: Institute for Defense Analyses, forthcoming, 6–7).

Table 5. PAUC Growth for Completed Programs in Bust and Boom Funding Climates for a Given Acquisition Policy and Process Configuration

	Bust	Boom	P-Value†
DSARC	37% (49)	13% (6)	0.077*
P-C DSARC	34% (11)	12% (26)	0.066*
DAB	40% (15)	2% (11)	0.002***
All Other	53% (35)	none	n/a
Total	42% (110)	15% (46)	< 0.0001***

† M-W U. DSARC: U = 81, n_1 = 49, n_2 = 6. P-C DSARC: U = 199, n_1 = 26, n_2 = 11; excludes T-45, JSTARS, and C-17. DAB: U = 23.5, n_1 = 15, n_2 = 11. Total: U = 1350.5, n_1 = 110, n_2 = 46.

* Significant at less than the 10 percent level.

*** Significant at less than the 1 percent level.

1. Cancellations and Truncations by MS B Cohorts

The question is whether cancellations and completion rates show a similar pattern. The relevant data are presented in Table 6. Cancellation frequencies are significantly different between the two climates for P-C DSARC and DAB. Note that the differences go in opposite directions—programs that passed MS B during the boom phase of P-C DSARC had a significantly lower cancellation rate than those that passed MS B in the bust phase, while the opposite is the case for the DAB configuration. There is then no consistent climate effect. Note also that the average cancellation frequency for all completed programs that passed MS B in bust periods is 19.8 percent, which is not significantly different from the 22.5 percent for programs that passed in boom climates.

Table 6. Cancellations in Bust and Boom Funding Climates for Completed Programs Given Acquisition Policy and Process Configuration

	Bust	Boom	P-Value†
DSARC	15.1% (11 of 73)	22.2% (4 of 18)	0.486
P-C DSARC	40.7% (11 of 27)	10.4% (5 of 48)	0.003***
DAB	20.7% (6 of 29)	42.9% (12 of 28)	0.072*
All Other	15.5% (9 of 58)	none	n/a
Total	19.8% (37 of 187)	22.5% (21 of 93)	0.888

† DSARC: FET; P-C DSARC FET; DAB: Chi-square; Total: Chi-square.

* Significant at less than the 10 percent level.

*** Significant at less than the 1 percent level.

The Bonferroni Correction is not required in this situation because the tests used make a single comparison separately for each of the acquisition policy and process configurations.

Table 7 reports data on average completion ratios for programs that passed MS B in boom and bust phases for the three acquisition policy and process configurations. Two of the configurations (DSARC and P-C DSARC) show significant differences between the two climates but, as with cancellations, they go in opposite directions—DSARC had a lower completion ratio for programs that passed MS B in the boom portion, while for P-C DSARC the programs that passed in the bust phase had the lower completion ratio. Again, at the total level, the average completion ratio is not significantly different between the two climates.

Table 7. Average Completion Ratios in Bust and Boom Funding Climates for Completed Programs Given Acquisition Policy and Process Configuration

	Bust	Boom	P-Value†
DSARC	148% (48)	77% (7)	0.056*
P-C DSARC	68% (13)	117% (28)	0.051*
DAB	116% (16)	122% (13)	0.757
All Other	113% (37)	none	n/a
Total	123% (114)	112% (48)	0.542

† M-W U. DSARC: U = 92, n_1 = 48, n_2 = 7; P-C DSARC: U = 112, n_1 = 28, n_2 = 13; DAB: U = 111.5, n_1 = 16, n_2 = 13; Total: U = 2570.5, n_1 = 114, n_2 = 48.

* Significant at less than the 10 percent level.

The Bonferroni Correction is not required in this situation because the tests used make a single comparison separately for each of the acquisition policy and process configurations.

Further comment on the pattern of cancellations for P-C DSARC and DAB is warranted. The cancellation frequency for P-C DSARC is significantly lower for MDAPs that passed MS B during its boom phase. This follows the pattern observed for PAUC growth and is consistent with the character of the Carlucci Initiatives, adopted in FY 1982. Among other things, the Carlucci Initiatives were intended to tighten up the DSARC process and to help ensure that DoD did not start more programs than reasonably anticipated funding would support.

There are, however, reasons for not accepting the statistical result at face value. First, the higher cancellation frequency of programs that passed MS B during FY 1987–FY 1989 is in part explained by the end of the Cold War.[14] Some of those MDAPs were later cancelled because, in the light of altered perceptions of the threats, they no longer seemed to be of enough utility to justify their cost. While the SARs do not spell out the

[14] The Berlin Wall fell on November 9, 1989, just over one month into FY 1990. The Soviet Union was formally dissolved in April 1991.

fact, there is little doubt that changes in the threat were a major factor in the cancellations of SRAM II, the Small ICBM, Peacekeeper Rail Garrison, and possibly some other programs from this cohort. To some extent, then, the high cancellation rate of the FY 1987–FY 1989 cohort is attributable to the end of the Cold War rather than to the prevailing acquisition regime and funding climate at MS B.

Second, the high cancellation frequency for the FY 1987–FY 1989 cohort also may in part be attributable to the Administration not following its own policy on new starts. The amount appropriated for DoD acquisition fell by about 30 percent from FY 1986 to FY 1989, and with the passage of Gramm-Rudman-Hollings (GRH) and developments in Eastern Europe, there was no reason to expect an increase over the then foreseeable future. In the years FY 1987–FY 1989, however, on average nine programs passed MS B annually. This rate was well above the rate for other bust periods (in particular, 6.7/yr. for FY 1970–FY 1980, 4/yr. for FY 1990–FY 1993, and 6.6/yr. for FY 1994–FY 2000). The relatively high new start rates suggest a decreased emphasis on the Carlucci Initiatives goal of not starting more MDAPs than likely future budgets could sustain. In fact, eight of the 11 cancellations from the new starts in the FY 1987–FY 1989 cohort occurred during FY 1990–FY 1993.

Finally, the programs that passed MS B during the post-9/11 boom (DAB, FY 2003–FY 2009) had a significantly above average cancellation frequency. The only readily visible reason that helps to explain this is Secretary of Defense Robert Gates' comparatively high willingness to cancel programs. (Gates was Secretary from December 2006 until July 2011.) Cancellation of seven MDAPs was clearly attributed to a Secretary of Defense in the relevant SARs. Gates accounted for at least four, and probably five, of these. The four cancellations attributed by SARs to Gates are enough to account for the above average cancellation rate among programs that passed MS B during FY 2003–FY 2009. In addition, Gates also probably initiated one cancellation attributed to the President and two that the SARs attribute to OSD.

The upshot of these comments is that, while the differences between the two climates for P-C DSARC and DAB are significant, their explanation probably lies outside the operation of the acquisition process during the relevant periods.

2. Cancellations and Truncations by Fiscal Year

One possible explanation starts by examining whether cancellations are associated with sharp declines in procurement funding. Pushed to the limit, the possibility raised is that in many—perhaps most—instances, programs are cancelled not because they have failed, but to close a funding gap.

Figure 3 shows the number of cancellations recorded in the database in each fiscal year over the period FY 1965–FY 2016. Two clusters of cancellations are evident in this figure, one centering on about FY 1990 and another centering on about FY 2010.

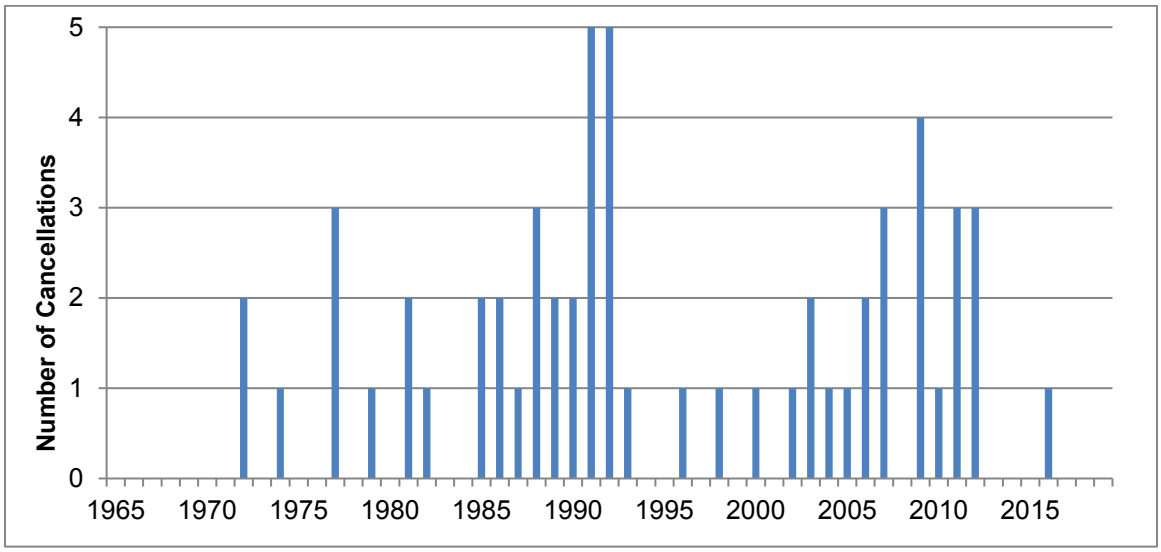

Figure 3. Number of MDAPs Cancelled Each Year, FY 1965–FY 2016

There were in fact two periods during which DoD procurement appropriation decreased from one year to the next, often sharply. The first of these, FY 1986–FY 1994, was the bust phase following the Carter-Reagan boom in defense budgets. Funding for DoD procurement fell by 29 percent in constant 2017 dollars over the last five budgets prepared by the Reagan Administration; it declined by an additional 50 percent over the four DoD budgets of the George H. W. Bush Administration. From peak procurement Budget Authority of $183.9 billion (FY 2017 dollars) in FY 1985, procurement fell to $64.8 billion in FY 1994, about 35 percent of its FY 1985 level.[15] Twenty-one MDAPs were cancelled during FY 1986–FY 1994.

The second period of declining funding was FY 2009–FY 2013. The financial crisis that sparked the Great Recession occurred towards the end of Calendar Year (CY) 2008, or approximately during the first quarter of FY 2009. The withdrawal of US troops from Iraq began in July 2009 and the Budget Control Act (BCA) was signed into law late in FY 2011. FY 2013 DoD procurement funding in constant 2017 dollars stood at about 55 percent of its FY 2008 level. Eleven MDAPs were cancelled during FY 2009–FY 2013.

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[15] These data, as well as similar funding data cited later, are in billions of constant FY 2017 dollars of Budget Authority. They are from Table 6-8 (p. 133ff) of the Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2017*.

Thirty-two MDAPs were cancelled during the 14 years of these two periods taken together, an average of nearly 2.3 cancellations each year. During the other 38 years, on average, about two MDAPs were cancelled every three years. A simple model was used to compute the probabilities of the observed cancellations for these two periods.[16] Using that model, the probability of observing 21 or more cancellations during the nine years FY 1986–FY 1994 is 0.003. The corresponding probability of observing 11 or more cancellations for the FY 2009–FY 2013 period was 0.04.

The absence of a cluster of cancellations during the early to mid-1970s may be surprising because this apparently was the bust phase of a boom-bust cycle associated with US involvement in the War in Vietnam. Withdrawal of US forces from Vietnam began in 1969. Virtually all US forces had been withdrawn by the end of 1972, but US material support for South Vietnam continued into 1975. In FY 1969, procurement funding in constant FY 2017 dollars was $116.8 billion. Using FY 2017 constant dollars, real procurement funding was down by 15.5 percent in FY 1970, and by FY 1975 it was just over half what it had been in 1969. This decline was less than that following the Carter-Reagan defense buildup but greater than the decline of FY 2009–FY 2012. A likely explanation for the comparatively low cancellation rate during FY 1970–FY 1975 can be found in changes over the relevant period in the composition of procurement funding. A large part of the increase in procurement funding during FY 1962–FY 1969 was for munitions and procurement to replace systems lost in combat, particularly aircraft. Insofar as procurement of MDAPs for modernization is concerned, there was little or no boom-bust cycle associated with the Vietnam War. [17]

Figure 4 is a display for completion ratios that parallels that in Figure 3 for cancellations. Of the 162 MDAPs for which we have a completion ratio, all but 43 acquired at least 75 percent of their MS B baseline quantity. The 43 MDAPs that did not are plotted in Figure 4 by their last year (the last year of production or, in cases for which that is not available, the year of their final SAR).

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[16] The model effectively treats each program as identical insofar as cancellation is concerned. There is a period of years (L) starting at MS B during which a program can be cancelled. The probability of cancellation during the relevant period is p. It is also assumed that the probability of cancellation is the same in each year of L; in particular, p' = p/L. There are assumed to be N programs at the start of each year, and any programs cancelled during the year are replaced at the start of the next year. In a given year, the probability that there will be k cancellations out of N programs is given by the binomial distribution B(N, k, p). The probability of k cancellations over s years is B(sN, k, p′).

[17] These comments are based on an unpublished IDA working database drawn from various US government sources. We are indebted to Dr. Daniel Cuda of IDA for providing these data.

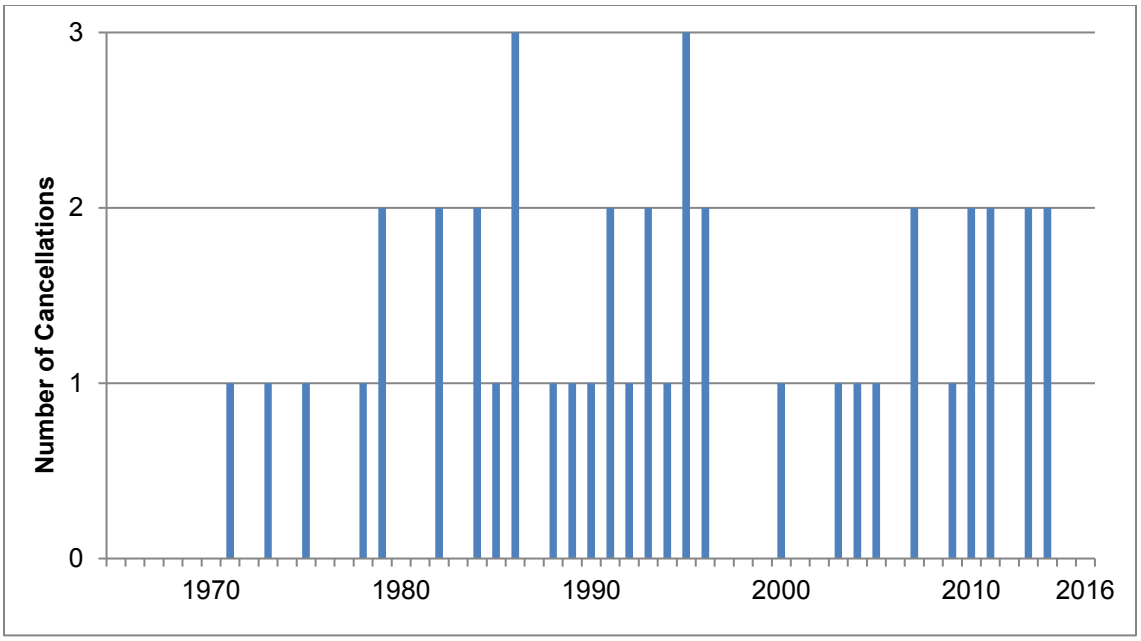

Figure 4. Number of MDAPs with a Completion Ratio of Less than 75 Percent, FY 1965–FY 2016 for Completed Programs

Figure 4 does not convey a strong impression that truncations clustered in the periods when the procurement budget was sharply decreasing (FY 1986–FY 1994 and FY 2009–FY 2013). The simple model described earlier also does not point to clustering.[18] During the period FY 1986–FY 1994, 12 MDAPs in the sample were concluded before having procured at least 75 percent of their MS B quantity. For reasonable assumptions, the model finds the probability of this observation to be about 30 percent; that is, not at all improbable. The corresponding probability for the period FY 2009–FY 2013 is 31 percent.

This is a surprising and not entirely plausible result. Just where the lines are drawn on the periods considered, and modest changes in the parameters of the model, do not substantially alter the finding. Probably of more importance is the distinction between when a decision to truncate a program was made and when the program ended. It is a distinct possibility that in some cases the decision to truncate a program was taken (say) two years before the program ended. If so, there may in fact be more clustering around

[18] It was assumed that 70 MDAPs were in production—that is, producing units that were fielded—and that 50 of these had not yet acquired 75 percent of their MS B baseline quantity. It was also assumed that programs did not reach 75 percent of MS B baseline quantity until their eighth year of production. Of the 263 programs in the database that were not cancelled, 43 acquired less than 75 percent of their MS B baseline quantity, for an overall rate of 0.163. The annual probability over the seven years during which a program was liable for truncation was then 0.023 (= 0.163/7).

FY 1990 and FY 2010 than Figure 4 indicates. On the evidence at hand, however, truncations do not appear to be associated with sharp decreases in procurement funding.

Finally, this discussion raises the question of whether the conclusions of Section C (on acquisition policy and process effects) change if the two funding climates (bust and boom) are replaced by three (stable, boom, bust). The question does not really arise for completion rates of less than 75 percent, which appear not to have clusters. Using the same approach as that used in Section D but distinguishing three climates (Bust-Stable, Bust-Declining, and Boom), no configuration has a cancellation frequency significantly different from that of the climate mean.[19]

E. Cost Growth and Cancellations and Truncations

High unit cost growth commonly is thought to be a major factor in MDAP cancellation decisions. This supposition is plausible because substantial growth in unit cost not only raises a question about affordability but also tends to call into question the relevance of the Analysis of Alternatives (AoA) that informed the decision to acquire the system: at some point, the increase in unit cost presumably would tip the balance in favor of another alternative.

The unit cost metric used here is PAUC—the sum of RDT&E cost and procurement cost, divided by the number of units acquired. PAUC growth is computed by comparing the MS B baseline value of PAUC—which can be thought of as a goal or a prediction—to the actual PAUC reported in the last SAR for the program, normalized to the MS B quantity. (The quantity normalization computations are described in Section E of Appendix B; the normalization accounts separately for units purchased with RDT&E funds and those purchased with procurement funds.) Both the MS B baseline and the actual value of PAUC are stated in constant dollars. Recall that "quantity normalized PAUC growth" will be abbreviated to simply "PAUC growth." There is no recognized standard for what constitutes high PAUC growth. For the purposes of this discussion, it is defined as PAUC growth against the MS B baseline of at least 50 percent.[20]

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[19] Fisher's Exact Test (FET) provides an indication that the DAB may have had a significantly higher cancellation rate in both Bust-Declining and Boom climates than the other configurations. There are cross-climate effects. In particular, the cancellation rate for the Bust-Declining period is significantly higher than that for the Bust-Stable period. Chi-square, P = 0.024.

[20] The Nunn-McCurdy Act in its current form defines a "critical" PAUC breach as one of 50 percent or more against the program's original baseline (typically the MS B baseline); a "significant" breach is one of at least 30 percent against the original baseline. These limits, however, are for PAUC growth, not quantity normalized PAUC growth. As the normalization is done for this paper, quantity normalized PAUC growth is higher than PAUC growth for programs that bought more than their MS B baseline quantities and lower for those that bought less.

A first interpretation of the conventional wisdom on unit cost and cancellations is that all programs with high PAUC growth are cancelled. The data provided in the "Completed" column of Table 8 bear on this possibility. Of the 156 completed MDAPs with a PAUC growth estimate, 43 had PAUC growth of at least 50 percent. The average PAUC growth of these programs was 93 percent, and PAUC at least doubled for nine of the 43. Clearly, then, not all MDAPs with high cost growth were cancelled.

Table 8. Distribution of PAUC Growth for Completed and Selected Cancelled MDAPs

Categories	Completed	Cancelled
At least 50%	43	10
Between 30% and 50%	19	0
Between 0% and 30%	66	10
Less than 0%	28	5
Total	**156**	**25**

A second possible interpretation of the conventional wisdom is that substantially all MDAPs that were cancelled had high unit cost growth. This possibility is difficult to assess because the final SAR for an MDAP that has been cancelled typically does not report the data required to estimate PAUC growth.[21] In some cases, however, it is possible to get an estimate of the amount of cost growth that occurred prior to cancellation. This is done by going back to the most recent SAR that reported the projected costs for developing the system and procuring some quantity of it. Proceeding in this way, we were able to estimate PAUC growth for 25 of the 58 MDAPs that were cancelled.

The right column of Table 8 presents PAUC growth data for these 25 programs. If these data are taken at face value, only 10 of the 25 cancelled programs showed high cost growth. Another 10 had PAUC growth of between 0 and 30 percent, and five showed negative PAUC growth. The conclusion from these estimates then clearly would be that not all cancelled programs had high cost growth.

The PAUC growth estimates in Table 8 for cancelled MDAPs, unfortunately, understate the true PAUC growth in that they do not capture the cost growth between the date of the SAR used and the termination of the program. In addition, there tends to be some delay in reporting cost growth that can be expected to occur based on the evidence

[21] It reports the RDT&E funding and any procurement funding that will actually have been expended when all effort on the program has ended. Usually these expenditures do not result in the production of any fully configured end items, and the SAR does not report what it would cost to complete the development program and procure some quantity of the system.

to date but which has not yet in fact materialized, and this might be especially the case for programs that were cancelled. The data in Table 8, then, are indicative but not conclusive.

Finally, a minimalist interpretation of the conventional wisdom is that the proportion of cancelled programs with a PAUC growth of at least 50 percent is higher than it is for programs that went into production. This is the case for the sample used here, although the difference is not statistically significant.[22] The difference for a PAUC growth of at least 30 percent also is not statistically significant between the 25 cancelled programs and those that went into production.[23]

There clearly is more going on with cancellations than PAUC increases. Combining the results on cancellations in this section with those of the preceding section, it might be useful to consider separately cancellations made in the two periods of sharply declining procurement funding and those made in other periods. While the same factors presumably are relevant, the relative importance of those factors may differ between cancellations in the two bins.

In contrast to cancellation, completion ratios are a matter of degree. As was noted in Section B, there is no bright line that separates truncations that are effectively a partial cancellation from those that are not. We look here at MDAPs that purchased 75 percent or less of the units that the program intended to purchase at the time of MS B. This line is arbitrary but not unreasonable.

Table 9 provides data on PAUC growth for programs with completion rates of less than 75 percent versus those with completion rates of at least 75 percent. A higher proportion of MDAPs with completion rates of less than 75 percent had PAUC growth of at least 50 percent, but the difference is not statistically significant.[24] There also was not a significant difference between the two groups in the proportion with PAUC growth of at least 30 percent.[25]

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[22] Chi-square, P = 0.204.

[23] Chi-square, P = 1.000.

[24] Chi-square, P = 0.397.

[25] Chi-square, P = 0.888.

Table 9. Distribution of PAUC Growth for Different Completion Rates

Category	Completion Rate Less than 75%	Completion Rate at Least 75%
At least 50%	12	28
Between 30% and 50%	2	16
Between 0% and 30%	14	51
Less than 0%	9	17
Total	**37**	**112**

There are sufficient data on completion rates to consider a more ambitious question: are higher completion rates associated with lower PAUC growth? As a point of departure, Figure 5 is a scatter for 95 MDAPs with a completion rate of less than 125 percent of the MS B baseline quantity.

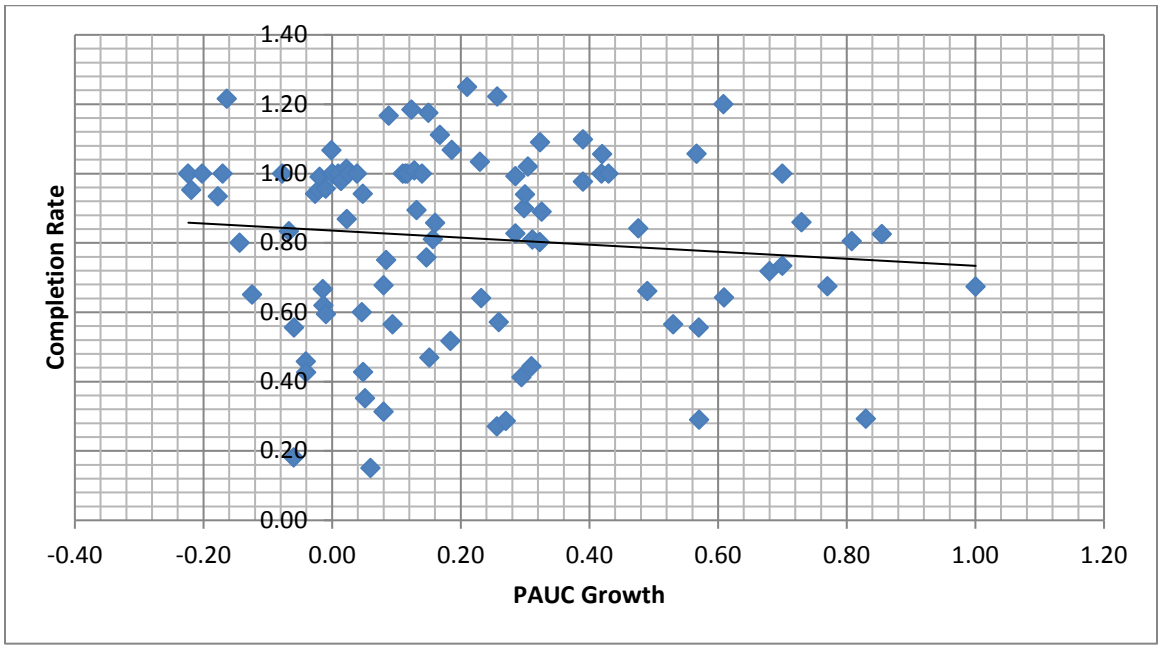

Figure 5. Scatter of Completion Ratios and PAUC Growth for 95 MDAPs

This scatter was constructed as a "best case" in support of a presumption that as PAUC growth increases, the completion rate falls. It omits eight programs for which PAUC growth was an outlier by a conventional statistical definition.[26] In addition, the scatter is limited to programs with completion rates of less than 125 percent because higher completion rates are positively associated with quantity normalized PAUC

[26] John Tukey defined an outlier as an observation that is at least 1.5 times the Inter Quartile Range above the third quartile or below the first.

growth, although the correlation is not statistically significant. This implausible result may reflect some underlying set of factors more complex than those considered here, but it seems more likely that it is simply spurious. In particular, it may be that the very high completion rates are largely due to either (1) instances in which successive generations of a system are left on the same SAR; or (2) an ill-considered MS B quantity baseline.

The best fit line through the scatter in Figure 5 has the expected negative slope—completion rates tend to become smaller as PAUC growth increases—but the slope is not statistically significantly different from zero.[27] The data in Figure 5, however, do not support a clear conclusion about the association of completion ratio and PAUC growth because they do not consider (1) technical performance; (2) the relative importance of the program; (3) the total size of the program; and (4) major changes in threats, especially those that came with the end of the Cold War. These presumably are given major weight in truncation decisions. Including a variable for post-Cold War adjustments does not substantially alter the results, however.[28] Within the resource limit of this research, however, there was no prospect of obtaining data on performance or relative importance for a substantial number of programs. We could not, then, untangle the effects of PAUC growth from the effects of these factors.

F. Conclusions

The clearest conclusion offered by this paper is that cancellations of MDAPs are concentrated in the two periods during which DoD procurement funding was declining, often sharply. This is not a surprising conclusion, but it is useful to know that cancellation of major programs is in fact one of the ways that DoD responded to large funding reductions. Truncations, in contrast, were not clustered in periods of declining procurement funding, which is surprising.

Apart from the association of cancellations and decreases in procurement funding, the conclusions offered are about what appears not to matter—or to matter much—in cancellation and truncation decisions:

- Possibly with the partial exception of FY 1987–FY 1989 within a funding climate there is no statistical association between cancellations or completion ratios of less than 75 percent and the acquisition policy and process prevailing when a program passes MS B.

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[27] The relationship was estimated with Ordinary Least Squares (OLS); the estimated slope was -10.2% (P = 0.312).

[28] The adjustment was assumed to have begun in FY 1991 and continued through FY 2000. The Berlin Wall fell in the first quarter of FY 1990 (Nov. 9, 1989). With the dummy variable for the post-Cold War adjustment included, the estimated slope was -10.1% (P = 0.319).

- Second, given acquisition policy and process configuration, there is no consistent climate association of funding climate with cancellations or completion ratios of less than 75 percent.
- Third, while cancelled programs on average had higher cost growth than programs not cancelled, most programs with PAUC growth of more than 50 percent were not cancelled. Clearly, there is more behind cancellations than cost growth. The evidence does not permit a similar conclusion for truncations, although it permits those so inclined to accept that higher PAUC growth tends to result in lower completion rates.

Is it reasonable to infer from these conclusions that large decreases in DoD funding such as those of FY 1986–FY 1993 and FY 2009–FY 2013 caused the cancellation of MDAPs that otherwise would have been completed? To be clear about this, it is necessary to distinguish between decisions to reduce the overall DoD acquisition portfolio and decisions about which programs to cancel. The latter involve a range of considerations—how well the programs are doing, how important they are, and the continued salience of the threats to which they respond, among others. The decision on the extent to which cancellations should be used to close a funding gap involves choices among bad alternatives—cancellations, delays in new starts, stretches of existing programs, acceptance of less costly alternatives in some cases, and adoption of very optimistic costing and programmatic decisions for both new starts and—to the extent possible—ongoing programs. Viewed from this angle, the root cause of many cancellations seems to be a mismatch between DoD's missions and functions, its force structure, and its funding.

Appendix A.
Background

This appendix provides brief descriptions of (1) the approach taken in this paper to the examination of unit cost growth, (2) each of the acquisition policy and process periods used, and (3) the funding climates. The material is drawn mainly from Institute for Defense Analyses (IDA) papers P-5126, P-5218, and P-5330 (Revised).[1]

A. Approach

Binning cost growth in terms of budget climate and acquisition policy and process is a departure from other statistical studies of cost growth and, for that reason, warrants a brief discussion. Statistical studies on cost growth in individual Major Defense Acquisition Programs (MDAPs) typically assume that most cost growth can be explained by characteristics of the program. The objective of these studies is to link program characteristics to cost growth and thereby provide a basis for identifying program characteristics—program "do's and do not's"—that will promote program success in terms of cost, schedule, and performance.

This paper, in contrast, does not attempt to explain *why* cost growth occurs but instead *when* it occurs, in chronological time and in the acquisition cycle, and *where* it occurs in terms of Department of Defense (DoD) processes. The analysis takes it as a point of departure that the proximate causes of Program Acquisition Unit Cost (PAUC) growth are decisions embedded in programs approved at Milestone (MS) B (unrealistic cost estimates or programmatic assumptions, for example) and decisions made during program execution (such as failing to act promptly enough on test results) that eventually caused the PAUC growth. With this assumption in the background, this paper and the others in the series in effect ask whether factors that cause (for example) cost growth tend to cluster in certain circumstances.

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[1] David L. McNicol and Linda Wu, "Evidence on the Effect of DoD Acquisition Policy and Process on Cost Growth of Major Defense Acquisition Programs," IDA Paper P-5126 (Alexandria, VA: Institute for Defense Analyses, September 2014); David L. McNicol, Sarah K. Burns, and Linda Wu, "Evidence on the Effect of DoD Acquisition Policy and Process and Funding Climate on Cancellations of Major Defense Acquisition Programs," IDA Paper P-5218 (Alexandria, VA: Institute for Defense Analyses, May 2015); and David L. McNicol et al., "Further Evidence on the Effect of Acquisition Policy on Cost Growth of Major Defense Acquisition Programs," IDA Paper P-5330 (Revised) (Alexandria, VA: Institute for Defense Analyses, August 2016).

The list of factors that can be expected to cause such clustering is short. The first of these is acquisition policy and process. For example, acquisition reforms adopted in mid-1969 strongly discouraged the use of fixed price contracts for development of MDAPs, and put in place a process for oversight of compliance with this and other acquisition policies. The second is funding climate, on the expectation that unrealistic or unduly optimistic assumptions are more likely to be embodied in the baselines of MDAPs that pass MS B in bust funding climates.

B. Acquisition Policy and Process Periods

The President of the United States or the Secretary of Defense, from DoD's early days, occasionally cancelled or initiated major acquisitions. MDAPs were also subject to review during the budget cycle by the Office of the Assistant Secretary of Defense (Comptroller) and the Office of Management and Budget. From the creation of the National Security Establishment in 1947 through 1960, however, the Office of the Secretary of Defense (OSD) had no institutionalized process for the oversight of major weapon system acquisitions.

The first steps towards installing an OSD-level acquisition oversight process were taken by then Secretary of Defense Robert McNamara in 1964. There have since been many dozens of changes in acquisition policy or process made by senior OSD officials and on the order of a dozen major changes directed by the Congress.

We organize the large number of policy and process changes by identifying time periods during which the main features of acquisition policy and process remained approximately the same. These are as follows:[2]

1. The McNamara-Clifford years, FY 1964–FY 1969
2. The Defense Systems Acquisition Review Council (DSARC), FY 1970–FY 1982
3. The Post-Carlucci Initiatives DSARC, FY 1983–FY 1989
4. The Defense Acquisition Board (DAB), FY 1990–FY 1993
5. Acquisition Reform (AR), FY 1994–FY 2000
6. The DAB Post-AR, FY 2001 to date

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[2] These categories are abstracted from J. Ronald Fox, *Defense Acquisition Reform, 1969 to 2009*: *An Elusive Goal* (Washington, DC: U.S. Army Center of Military History, 2011).

1. McNamara-Clifford, 1964-1969

The best known of McNamara's changes in OSD decision-making processes was the creation of the Office of Systems Analysis (OSA) and the Planning, Programming, and Budgeting System (PPBS), which moved decisions on what major systems to procure to the Secretary of Defense level. OSA and PPBS so overshadowed development of an OSD-level acquisition oversight process that the latter is no longer part of the collective memory of the DoD acquisition community. Nonetheless, the evolution of the OSD-level acquisition process began with initiatives taken by McNamara in the mid-1960s.

Provisions for milestone reviews appeared in 1964 with the issuance of DoD Directive (DoDD) 3200.9, *Initiation of Engineering and Operational Systems Development*.[3] This original version of the directive set one point at which OSD—in principle, the Secretary of Defense—approval was required for an acquisition program to proceed. In 1965, a second decision point was added.

The two milestones of the revised DoDD 3200.9 defined an acquisition cycle with three phases. The first of these "was called *concept formulation*. During concept formulation OSD and the Service(s) involved assured themselves that they were buying the right system to meet real needs and that the technology was fully ready."[4] Concept formulation typically was initiated by a Service, but involved the Director, Defense Research and Engineering (DDR&E) and the Office of the Assistant Secretary of Defense for Systems Analysis (OASD(SA)), and included what would now be called an Analysis of Alternatives, led by OASD(SA). It also apparently included what would later be called a Mission Element Need Statement and also the main parts of an Acquisition Strategy and plans for oversight of the program as it proceeded.

Approval to proceed from the Concept Formulation phase authorized the Service sponsoring the program to fund at least one company to prepare a definitized contract proposal. Preparation of a definitized contract was the second phase of the acquisition process. The third phase was the award of a contract for development and procurement of the system. That is to say, the second of DoDD 3200.9's milestones combined what now would be called MS B and MS C authority.

The 1965 revision of DoDD 3200.9 stated that one of the purposes of the Concept Formulation phase was to "[p]rovide a basis for a firm fixed price or fully structured

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[3] The first version of DoDD 3200.9 was issued in 1964. A revision that made provision for the Contract Definition Phase was issued July 1, 1965. See Thomas K. Glennan, Jr., "Policies for Military Research and Development," RAND Paper P-3253 (Santa Monica CA: The RAND Corporation, 1966), 12.

[4] William D. O'Neil and Gene H. Porter, "What to Buy? The Role of Director of Defense Research and Engineering (DDR&E)—Lessons from the 1970s," IDA Paper P-4675 (Alexandria, VA: Institute for Defense Analyses, January 2011), 30.

incentive contract for Engineering Development."[5] In addition, McNamara directed the use of Total Package Procurement (TPP) when it was judged to be practicable and, when not, a Fixed Price Incentive Fee (FPIF) or Cost Plus Incentive Fee (CPIF) contract. By 1966, McNamara had concluded that TPP contracts were in fact not a practicable way to acquire most major weapon systems,[6] although acquisition policy apparently still had a tilt towards fixed price contracts, even for development.

The OSD-level milestone reviews were structured around what was then called the Development Concept Paper (DCP). The requirement for a DCP was instituted in 1965 by the DDR&E,[7] and in 1968, it was required in order to initiate any major development project. DDR&E coordinated initial DCPs with concerned OSD offices (and probably the Joint Staff and other Services) and with what now would be called the Milestone Decision Authority (MDA) for the initial DCP.[8] Once approved by DDR&E, the proposed new start went to the Secretary of Defense, although the sources consulted do not indicate whether it went as a separate action or as part of the Service's budget submission. It is also not clear which OSD official was the MDA for the second milestone.

2. The 1969 Packard Reforms

The start of the second acquisition period is marked by reforms initiated by then Deputy Secretary of Defense David Packard in mid-1969. The elements of the Packard reforms fall into three main categories. First, Packard clarified and formalized the OSD-level acquisition oversight process that had emerged under McNamara and Clifford. This was achieved through a combination of steps:

- The DSARC was established to advise the MDA at each milestone.
- DDR&E was designated as the MDA at MS I and MS II; the Assistant Secretary of Defense for Installations and Logistics was the MDA for MS III.
- The Development Concept Paper was renamed the Decision Coordinating Paper (retaining the acronym).

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5 DoDD 3200.9, *Initiation of Engineering and Operational Systems Development*, July 1, 1965, V.B(1).

6 Gordon Adams, Paul Murphy, and William Grey Rosenau, *Controlling Weapons Costs: Can Pentagon Reforms Work?* (New York: Council on Economic Priorities, 1983), 19–20. A TPP contract is one that covers EMD, at least a significant portion of procurement, and at least part of the support of the system (for example, depot maintenance). Fox also notes that McNamara moved to consolidate acquisition functions in defense agencies—e.g., the agency that became the Defense Logistics Agency—and promoted the use by program managers of particular management tools such as PERT and earned value.

7 Fox, *Defense Acquisition Reform*, *1969 to 2009*, 24–47, provides a sketch of how the process evolved and worked during the 1960s.

8 See C. W. Borklund, *The Department of Defense* (New York: Frederick A. Praeger, 1969), 83.

- Acquisition policy and the process of OSD-level milestone and program reviews were laid out in a new directive (DoDD 5000.1) and a new top-level process instruction (DoDI 5000.2).[9]

As each of these steps had antecedents in the McNamara-Clifford process, it seems reasonable to say that they were evolutionary rather than revolutionary.[10]

Second, Packard made changes to policy on contract types. Picking up on this topic where McNamara had left off, he ruled out the use of TPP and discouraged the use of FPIF for development contracts in favor of CPIF. (Cost Plus Award Fee may not have been included in the contracting play book yet). As a general matter, Packard's policy was to match contract terms to the riskiness of the acquisition.

Third, and finally, Packard redefined the milestones so as to separate the decision to allow the program to enter Engineering and Manufacturing Development (EMD) (now MS B) from the decision to enter the Production phase (now MS C) and required OSD-level approval of each decision. He also collapsed DoDD 3200.9's Contract Definition phase into the new and broader Validation phase, which has at various times since been called Demonstration and Validation, Program Development and Risk Reduction and, currently, Technology Maturation and Risk Reduction. MS I (now MS A) authorized entry into this phase. These changes were more revolutionary than evolutionary.[11]

Packard's reforms were at the time explained as a return to Components of the authority to manage major acquisition programs. McNamara had an active role making decisions about some major programs, and against this background Packard's reforms were a return to Components of management responsibility. Under the new acquisition directives, the Secretary of Defense, while retaining full legal authority over acquisition programs, would act through the established acquisition process except in extraordinary circumstances. Decisions at the DSARC level were advisory to the Secretary and Deputy Secretary of Defense but, apart from exceptional cases, they probably reached that level by way of the Service's proposed budgets (and the Comptroller was the backstop enforcer of the requirement for milestone approval before a program could advance to the next stage). This implied less OSD-level control over some major acquisitions—those in

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9 DoDD 5000.1, *The Defense Acquisition System*, May 12, 2003; and DoDI 5000.2, *Operation of the Defense Acquisition System*, May 12, 2003.

10 Fox, *Defense Acquisition Reform, 1969 to 2009*, 57, provides a useful schematic comparison of the DoDD 3200.9 milestones and those of Packard's DoDD 5000.1/DoDI 5000.2.

11 DoDI 5000.2, issued October 23, 2000, formally established MSs A, B, and C (in place of MSs I, II, and III) as the main decision points for an MDAP. The definitions are such that MS B is placed several months earlier in the process than MS II.

which McNamara had been actively involved. The DSARC, however, had a greater substantive scope than the 1960s process for the more typical program and was more tightly organized. For the large majority of major acquisition programs, then, the new DSARC process probably was more effective.[12]

The process instituted by Packard in mid-1969 had all of the basic features that are still central to OSD-level oversight of MDAPs—three milestones, with definitions similar to those used now; formal milestone reviews; a body to advise the MDA; and a document(s) that described the basic features of the program, provided a vehicle for staff inputs, and set down the cost, schedule, and performance goals that the program was to meet.[13] This is an important point because it implies that the effects of Packard's reforms would endure, so long as the process was not altered in a fundamental way.

3. The More Recent Periods

The vehicle for the transition from the first phase of the DSARC (FY 1970–FY 1982) to the second (FY 1983–FY 1989) was the Carlucci Initiatives, named after then Deputy Secretary of Defense Frank Carlucci. These were developed during CY 1981 and implemented during FY 1982–FY 1983. The Carlucci Initiatives did not involve any major changes in the DSARC process or in the policies Packard had established; in these terms, the Carlucci Initiatives were more reaffirmation than change. The Initiatives, however, included measures designed to coordinate decisions on MDAPs made in the PPBS and those made in the DSARC process. Important statutory changes were also made during 1982 and 1983.

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[12] Clark A. Murdock, *Defense Policy Formation* (Albany, NY: State University of New York Press, 1974), 155–179, disagrees with this judgment. Murdock is primarily concerned with Systems Analysis and resource allocation, but also comments specifically on the acquisition process. In particular, he notes that the new Decision Coordinating Paper did not provide "any mechanism for ongoing managerial control." This is accurate in that the Packard reforms placed management of the programs in the hands of the Services. It is incomplete in that the Services were responsible for staying within what would later be called the Acquisition Program Baseline, and the MDA was enjoined to act in cases in which they did not.

[13] In January 1972, the DSARC process was expanded to include an independent cost estimate at MS II and MS III provided by the Cost Analysis Improvement Group (CAIG), newly established by a memorandum signed by Melvin Laird on January 25, 1972. A December 7, 1971 memorandum signed by David Packard directed the Military Departments to begin using "independent parametric cost analysis." See Donald Srull, ed., *The Cost Analysis Improvement Group: A History* (McLean, VA: Logistics Management Institute (now LMI), 1998), 47–48. Since the implementation of the Weapon Systems Acquisition Reform Act of 2009 (WSARA), the independent cost estimates have been provided by the Cost Assessment Deputate of the Office of Cost Assessment and Program Evaluation (CAPE).

The DSARC was followed by the DAB.[14] While the DAB itself bears a strong family resemblance to the DSARC, the statute that created it also created the position that is now called Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) and Service Acquisition Executives, who reported to the USD(AT&L); designated USD(AT&L) as the MDA for most MDAPs; and removed the Service chiefs from the acquisition chain of command. In addition, the statute created the position of Vice Chairman of the Joint Chiefs of Staff (VCJCS) and prompted a new requirements process centered on the VCJCS.

AR (FY 1994–FY 2000) was to a large extent intended to put acquisition of major weapon systems on a more commercial basis and make it easier for firms outside the defense sector to sell to DoD. Contracts were structured so that defense contractors assumed more responsibility for system performance; correspondingly, DoD's role in contract management decreased. OSD oversight of MDAPs also was relaxed somewhat. Substantial cuts in acquisition staffs at both the OSD level and Service Headquarters level were made, and senior decision makers took a more permissive attitude towards cost growth.

The post-AR DAB period was marked by the arrival of a new administration in January 2001. This period saw no overt rejection of AR, but most of its initiatives were no longer pursued. The new administration seemed implicitly to favor a return to the *status quo ante* in OSD-level oversight of acquisition programs.

In 2006, the Congress strengthened the Nunn-McCurdy Act, which had been passed in 1982.[15] In 2009, the Congress passed the Weapon Systems Acquisition Reform Act (WSARA), which made several changes that may prove to be consequential.

C. Funding Climates

It is important to realize that funds appropriated for procurement are a lagging indicator of a change in budget climate. Funding and programmatic decisions embedded in the MS B baselines of MDAPs are made at least one or two years before the President's Budgets in question are submitted to the Congress. Consequently, those decisions necessarily reflect expectations held by decision makers about the future DoD

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[14] There is some uncertainty about when the Post-Carlucci Reforms DSARC should end and the DAB period should begin. The relevant statutes were passed in December 1985 (first quarter FY 1986), and the DAB began functioning under that name in late FY 1987 or early FY 1988; however, DoD did not implement the full set of reforms required by statute until 1990. We have for that reason set the line at 1990.

[15] The Nunn-McCurdy Act imposes reporting and other requirements that senior DoD officials must meet if an MDAP breaches certain unit cost thresholds.

budget climate, and the breakpoints between different budget climates should mark the points at which there were major shifts in expectations.

It is also important to recognize the distinction between the development of the DoD budget request for acquisition and the amount the Congress eventually appropriates. The Components' acquisition programs are built subject to funding constraints specified by senior Component officials (in particular, the Service Secretaries) based on fiscal guidance they are given by the Secretary of Defense. It is reasonable to assume that expectations about future funding levels are formed as much by "this year's" fiscal guidance as by "last year's" congressional appropriation.

We used four events to identify the breakpoints between funding climates: (1) the invasion of Afghanistan by the USSR in late December 1979; (2) passage of the Gramm-Rudman-Hollings Act in December 1985; (3) the terrorist attack on the United States on September 11, 2001; and (4) the start of the withdrawal of US forces from Iraq in late FY 2009. Senior decision makers could reasonably expect each of the events identified to signal major and sustained changes in the defense funding climate, which in fact they did.

1. The First Bust Climate

DoD procurement funding increased markedly during the first three years of the Kennedy administration (CY 1961–CY 1963) and remained relatively high through the 1960s. A large part of the increase in procurement funding during FY 1964–FY 1969, however, was for munitions and procurement to replace systems lost in combat, particularly aircraft. Insofar as modernization of weapon systems was concerned, there was little or no boom associated with the Vietnam War.[16]

Gerald Ford was sworn in as president on August 9, 1974, about six weeks into FY 1975. The FY 1976 budget, preparation of which was far advanced when Ford became president, increased procurement by 13.5 percent. The amount appropriated for procurement in FY 1977 increased by an additional 30 percent, and the amounts appropriated for procurement during the next two years were only modestly lower.

There are three main reasons for concluding that the FY 1976 and FY 1977 increases did not cause a major shift in expectations about defense spending. First, they basically reversed sharp declines in procurement funding during the years 1970–1975, roughly the period of the "Peace Dividend" that had accompanied the end of the War in Vietnam.

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[16] These comments are based on an unpublished IDA working database drawn from various US government sources. We are indebted to Dr. Daniel Cuda for providing these data.

Second, there was no political consensus in favor of a sustained substantial increase in funding for DoD procurement. As evidence of this point, during the 1976 campaign, President Carter "pledge[d] to reduce the defense budget by $7 billion and submit a balanced budget in fiscal year 1981."[17]

Third, while Ford opposed cuts to defense spending, the material consulted for this paper (Ford's three State of the Union addresses and campaign material) did not indicate that he attempted to establish a consensus favoring large increases in DoD spending. It also is far from clear that he was in a position to do so during most of his presidency. The Democrats controlled both houses of the Congress. In his inaugural address to the Congress, Ford said: "I am your man, for it was your carefully weighed confirmation that changed my occupation." That is, his legitimacy as president was derived from the Congress rather than from election by the people.

The Carter administration followed through on his campaign commitment by reducing the FY 1978 DoD budget request left by the Ford administration by about $3 billion. Moreover, on August 17, 1978, President Carter vetoed the 1979 Defense Authorization Act. The veto message implies that the Congress had put a $2 billion nuclear powered carrier into the budget Carter had submitted from the Ford administration and cut some other procurement programs, some readiness funding, and some RDT&E funding. Carter wanted the carrier removed from the budget and the other funding he had requested restored. The veto was sustained. As these facts suggest would be the case, DoD Budget Authority (BA) was lower for FY 1978 and FY 1979 than it was for FY 1977, and FY 1980 was only slightly larger.

2. Start of the First Boom Climate

The Soviet invasion of Afghanistan in late December 1979 (three months into FY 1980) prompted a change in the Carter administration's policy on defense spending. One source states that "only a month after the Soviet invasion of Afghanistan, Carter called for increases in defense spending of 4.6 percent per year, every year over five years."[18] Carter's State of the Union address delivered on January 21, 1980, listed as one of his few new proposals "initiatives implementing my response to the Soviet invasion of Afghanistan." The "Defense Spending" portion of the State of the Union address stated that requested FY 1981 funding authority was a more than 5 percent real increase over the funding requested for FY 1980. It goes on to characterize this as "a growth rate for

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[17] Frank L. Jones, *A "Hollow Army" Reappraised: President Carter, Defense Budgets, and the Politics of Military Readiness* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2012), 16.

[18] Andrew Krepinevich, "What Would Jimmy Carter Do?," Defense One, March 11, 2014, http://www.defenseone.com/ideas/2014/03/what-would-jimmy-carter-do/80335/?oref=search_what%20would%20jimmy%20carter%20do.

defense that we can sustain over the long haul." In fact, the real increase in enacted DoD BA for FY 1981 was 12 percent for DoD as a whole and about 25 percent for procurement.

President Reagan, who took office in January 1981, requested increases in DoD funding that went well beyond what the Carter administration had planned. By FY 1985, DoD funding for procurement was more than 70 percent above what it had been in FY 1981.

3. The Second Bust Period

Congressional appropriations for defense procurement peaked in FY 1985. The Congress did not enact the increase in DoD funding for FY 1986 requested by the administration, and in December 1985 passed the Gramm-Rudman-Hollings (GRH) Act, which provided for sequestration to satisfy budget targets.

None of this was known, however, when the FY 1986 DoD budget request was sent to the Congress in late January or early February 1985, and the defense buildup was in full swing during FY 1983 through FY 1985 when the FY 1986 request was being developed. For that reason, this paper takes FY 1986 as the last year of the Carter-Reagan boom climate.

The Congress cut DoD funding for FY 1987 about 3 percent below the FY 1986 level. Cuts in defense spending continued through the end of the Reagan administration. Procurement funding for FY 1987 was down about 16 percent from its FY 1986 level and dropped modestly further over the next three fiscal years. Additional large drops came after the fall of the Berlin Wall on November 9, 1989 (first quarter FY 1990) and the collapse of the Soviet Union on December 25, 1991 (first quarter FY 1992). By the mid-1990s, DoD procurement funding had returned to about the post-Vietnam War levels of the mid-1970s and was little more than one-third of its peak (FY 1985) level. Altogether, the second bust phase continued—for a total of 16 years—through FY 2002.

4. The Second Boom Period

The defense spending boom that followed was prompted by the Al Qaeda attacks of September 11, 2001 (late FY 2001) and the subsequent wars in Afghanistan and Iraq. The question is where the start of the boom climate should be placed—at FY 2001, FY 2002, or FY 2003?

George W. Bush was inaugurated on January 20, 2001. It is not clear that the outgoing Clinton administration submitted its final (FY 2002) budget to the Congress. The Bush administration apparently submitted a pro forma budget (*A Blueprint for New Beginnings*) on February 29, 2001, and a complete FY 2002 request proposal on April 9. The Bush administration also requested a $5.2 billion increase in the FY 2001

appropriation. According to the budget news release, this was primarily for Military Personnel (MILPERS) and Operations and Maintenance (O&M). As a candidate, Bush had not committed to increasing procurement, and his proposed budget for FY 2002 did not do so. In fact, procurement was actually $1.4 billion *lower* than the FY 2002 column of the FY 2001 Clinton Future Years Defense Plan.

Post 9/11, the budget climate was radically different. On December 28, 2001 (end of the first quarter of FY 2002), the Congress adopted an emergency supplemental for FY 2001, even though it had ended three months earlier, and on January 10, 2002 adopted an emergency supplemental for FY 2002. The spending plans that went into the proposed FY 2002 budget could not have been influenced by these events.

Planning for the FY 2004 DoD budget certainly took place in a boom climate. That is less clearly true of the FY 2003 budget. The FY 2003 DoD budget submitted February 4, 2002 was about 10 percent above the FY 2002 budget request and, more important for present purposes, provided for about a 10 percent increase in procurement funding. Barely four months elapsed between 9/11 and the submission of the FY 2003 DoD budget. On the supposition that major changes in acquisition programs could have been made within that amount of time, this paper places the start of the post-9/11 boom climate at FY 2003.

DoD funding for procurement increased in FY 2003 by about 20 percent over the preceding year and continued to increase through FY 2008. FY 2009 probably should be counted as the last year of this second boom period because the Great Recession began in its first quarter and the withdrawal of US troops from Iraq began in July of 2009. Expectations of a decline in defense spending developed at that time, and were solidified by passage of the Budget Control Act of 2011, which was signed into law in August 2011.

Appendix B.
The Data

A compact disc (CD) in a pocket on the inside back cover of this paper contains the database used in this research. The CD also contains several other files that help to document or explain the data. This appendix provides background information that facilitates access to and use of the files on the CD.

A. Cost Growth Metric and Ground Rules

The principal cost growth metric used in this paper is quantity normalized Program Acquisition Unit Cost (PAUC) growth in program base year dollars. In most instances, the PAUC growth figure used is measured from the MS B baseline. PAUC includes Research, Development, Test, and Evaluation (RDT&E) funding as well as procurement funding.

Each of the programs in the database with a PAUC growth estimate completed Engineering and Manufacturing Development (EMD), went into production, and fielded at least some units to operating forces. We follow the convention of not including in the database any MDAP that was not at least five years beyond EMD, so that cost growth would have time to appear. The most recent Selected Acquisition Reports (SARs) available for this paper were those for December 2015, so the most recent programs included are those that passed MS B in FY 2010. The database contains an estimate of PAUC growth for 184 of the MDAPs that entered EMD during FY 1965–FY 2010.

The estimates mainly are drawn from the database developed for IDA Paper P-5330 (Revised), which in turn evolved from the database for IDA Paper P-5126.[1] The cost growth observations for FY 1965–FY 1969, however, and a few of the observations for FY 1965–FY 1989, are drawn from other studies, as is discussed below.

Figure B-1 is a histogram of the cost growth estimates in the database used for this paper. The paper used the 162 completed MDAPs that passed MS B during the period

[1] David L. McNicol et al., "Further Evidence on the Effect of Acquisition Policy on Cost Growth of Major Defense Acquisition Programs," IDA Paper P-5330 (Revised) (Alexandria, VA: Institute for Defense Analyses, August 2016); David L. McNicol and Linda Wu, "Evidence on the Effect of DoD Acquisition Policy and Process on Cost Growth of Major Defense Acquisition Programs," IDA Paper P-5126 (Alexandria, VA: Institute for Defense Analyses, September 2014).

FY 1965–FY 2009 for which both an Average Procurement Unit Cost (APUC) and a PAUC estimate were available.

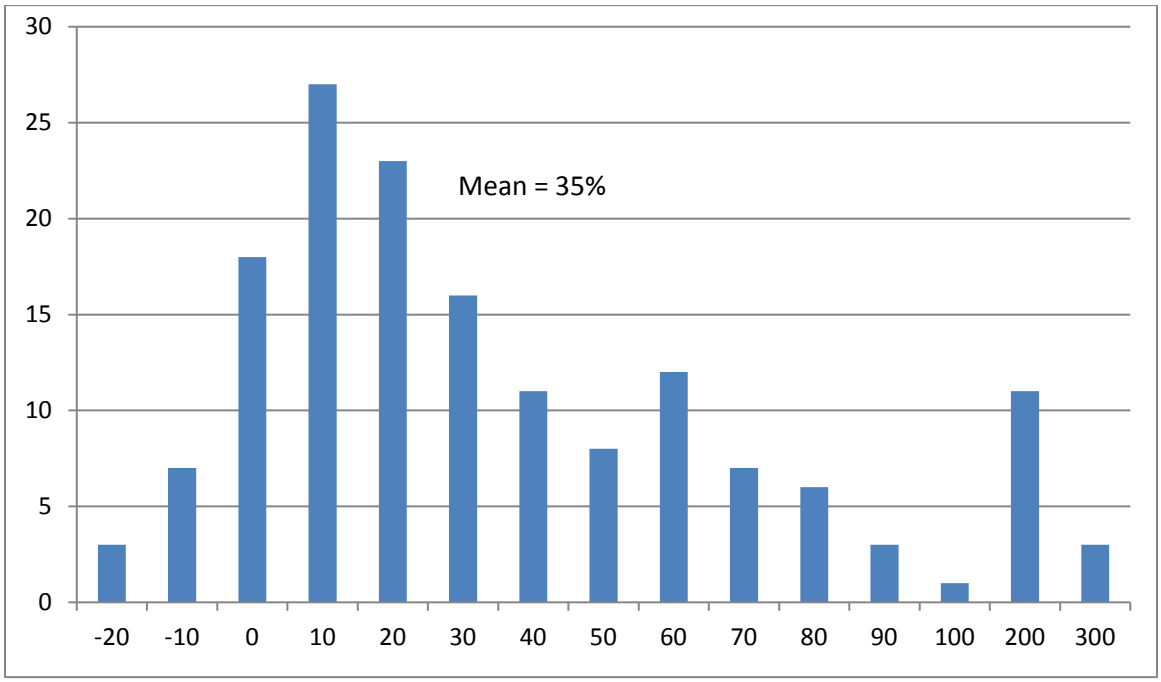

Figure B-1. Histogram of Quantity Normalized PAUC Growth from the MS B Baseline for Completed MDAPs

B. Business Rules

Almost all of the data used in this research were taken directly or indirectly from SARs. SARs filed in FY 1997 and subsequent years are available through the Defense Acquisition Management Information Retrieval (DAMIR) system. Many SARs filed before FY 1997 are available on an Office of the Under Secretary of Defense (Acquisition, Technology and Logistics) (OUSD(AT&L)) SIPRNet site. These two sources provided SARs under about 345 distinct labels.

Not all of these distinct labels are distinct programs. Three steps are needed to get from the list of distinct SAR labels to a list of MDAPs:

1. During the 1970s, each Component involved in a joint program sometimes filed a SAR. These SARs reported the same program data. The database used in this research includes only the data reported (for the entire program) in the SAR filed by the lead Component.
2. The program name used on the SAR often changes over the acquisition cycle for a given program. For example, the OH-58D Kiowa Warrior was first reported as the Army Helicopter Improvement Program (AHIP). In most cases the database

uses the name under which the last (or, for ongoing programs, most recent) SAR was filed.

3. Multiple MDAPs that have passed MS B are sometimes combined into a single MDAP. Conversely, a single MDAP that has passed MS B is sometimes split into two or more separate MDAPs. If the data permitted (and they often did not), our rule was to maintain the program(s) as they had been defined at MS B.

For the reasons noted above, the database does not include any MDAPs that passed MS B after FY 2010. In addition, the following were excluded from the main database:

- Major Automated Information Systems (MAIS),
- Chemical Demilitarization Programs,
- Ballistic Missile Defense programs managed by the Ballistic Missile Defense Agency and its predecessors,
- Programs that filed a SAR but were never designated as an MDAP, and
- Programs cancelled before they passed MS B or before they were designated as an MDAP.

These exclusions were indicated by the purpose of the analysis, which is to gauge the effect of different OSD-level acquisition regimes and funding climates on MDAP outcomes. The database then should include only programs subject to OSD-level acquisition policy and process. To at least a significant extent, the excluded programs differed from the MDAP norm. The exclusions therefore resulted in a main database that includes 316 MDAPs that entered development during the period FY 1965–FY 2010.

Most of the MDAPs in the database passed MS B at the OSD level. Some, however, entered at MS III/C, obtained both MS B and Low Rate Initial Production authority in a single OSD-level review, or passed MS B at the Service level and later became Acquisition Category (ACAT) I programs. These cases are noted in the database for programs that became MDAPs in FY 1989 or later, but not reliably noted for programs begun earlier.

Finally, it proved to be necessary to adopt a clear criterion for program cancellation. In the database, a program is classified as cancelled if:

- The program did not result in production of any fully configured end items, or
- Any fully configured end items produced were used only for testing and development.

Application of this definition was not clear-cut for six programs that passed MS B at the Service level, later filed SARs, and subsequently were cancelled. We retained on the list

of cancelled programs the five that had been designated as an ACAT I program and excluded the one that had not.[2]

Two other programs were counted as cancelled, although they did not exactly satisfy the criteria stated. The C-27J was included on the list of cancelled programs because the 21 C-27Js produced were placed directly in long-term storage and later transferred to Special Operations Command and the US Coast Guard. Roland was included, although the system was produced in the United States in limited quantities and issued to a single National Guard battalion, which falls into a gray area between issue of the system to active duty units and its use only for development, experiment, and training.

The file "Program Notes" (provided on the included CD) provides some information bearing on each of the 58 cancellations we identified. We found 12 additional programs that filed one or more SARs during FY 1959–FY 2009 and were cancelled. These 12 were not included on the list of cancelled programs because they were either cancelled before passing MS B, were never designated an ACAT I program, or were cancelled after they fell below the ACAT I level. They appear as numbers 59–70 in "Program Notes."

C. Coverage

As was noted above, the database includes 58 MDAPs that were cancelled (as an ACAT I program) after passing MS B and includes 254 programs that went into production. We have APUC and PAUC estimates for 185 of the MDAPs that went into production, of which 32 were still underway as of the December 2015 SARs. Table B-1 reports the relevant data broken down by the nine time periods used in the statistical analysis. Overall, the database reports a cost growth estimate for about 70 percent of the MDAPs that went into production.

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[2] AN/WQR-Advanced Deployable System, AQM-127A Supersonic Low Altitude Target, Advanced Seal Delivery System, ASM-135A Air-Launched Anti-Satellite System, and Land Warrior were retained on the list of cancelled programs. Extended Range Munition was cancelled before it was designated an ACAT I program.

Table B-1. MDAPs in the Database Not Cancelled, with an APUC and a PAUC Estimate, by Bust/Boom Time Periods

Period (FY)	Went into Production	No. with APUC & PAUC	Percent with APUC & PAUC
1965–1969	21	16	76%
1970–1980	62	49	79%
1987–1989	16	11	69%
1990–1993	14	11	78%
1994–2000	40	30	75%
2001–2002	11	6	55%
Total	**164**	**123**	**73%**
1981–1982	14	7	50%
1983–1986	45	31	69%
2003–2009	31	24	77%
Total	90	62	69%
Grand Total	**254**	**185**	**73%**

D. Sources of Cost Growth Estimates

Table B-2 reports the sources of the APUC and PAUC estimates used in this paper. Nearly half of the total was taken from an MDAP cost growth database developed and maintained by the Office of Program Analysis and Evaluation (PA&E) Resource Analysis deputate. The PA&E cost growth database is documented in a briefing by John McCrillis given at the 2003 Annual DoD Cost Analysis Symposium.[3] The briefing is included on the CD provided on the inside back cover of this paper.

Table B-2. Sources of the APUC and PAUC Growth Estimates Used in Different Periods

Period (FY)	PA&E	P-2722	RAND	In -House	Total
1964–1969	0	16	0	0	16
1970–1979	36	8	2	0	46
1980–1989	45	0	4	1	51
1990–1999	7	0	0	32	36
2000–2009	0	0	0	30	25
2010	0	0	0	3	3
Total	**88**	**24**	**6**	**66**	**184**

[3] John McCrillis, "Cost Growth of Major Defense Programs," Briefing (presented at the Department of Defense Cost Analysis Symposium, Williamsburg, VA, January 30, 2003).

APUC and PAUC growth estimates for an additional 24 MDAPs were taken from IDA Paper P-2722.[4] The provided CD includes the main volume of P-2722, as well as an Excel workbook with the data. The next section of this appendix describes how the P-5126 cost growth estimates were made.

Communication from the RAND Corporation provided updates to the FY 2015 SARs of estimates for six MDAPs published in a 1996 study[5] of APUC and PAUC growth estimates normalized to the MS B baseline.

Finally, APUC and PAUC growth estimates for 66 MDAPs were made in-house as part of the work on this project. Fifty-eight of the MDAPs in the PA&E cost growth database were still ongoing at the time of the final PA&E update (that is, when the December 2004 SARs were filed). These were updated with data from the December 2015 SARs. In addition, APUC and PAUC growth estimates for MDAPs that passed MS B during FY 2008–FY 2010 were made, again using the December 2015 SARs.

The PA&E estimates were constructed through a detailed examination of the SAR variances. The IDA P-2722, IDA P-5126, and RAND estimates were made with data at a much more aggregated level. The methods used were essentially the same, but it is reasonable to assume that they differ in detailed ways not captured by the general characterization each offers of the method used. P-2722 did not in all cases follow the business rules used in P-5126 and this paper.

These four sources use the same definitions of the relevant cost terms and are based on SAR data. Each also, in most instances, measures cost growth from the MS B baseline when it is available and reports quantity normalized unit cost growth. Thus, a PAUC estimate from, for example, P-2722 means the same thing as an APUC estimate from the other three sources.

There were several MDAPs from the 1960s and 1970s for which we had two APUC and PAUC growth estimates. The decisions on which of the alternative estimates to use was entirely rules-based. The PA&E database did not provide estimates for MDAPs that entered EMD during FY 1965–FY 1969. The unit cost growth estimates used for FY 1965–FY 1969 are from P-2722. In addition to the SAR data, P-2722's estimates in many cases reflected other sources of information, including material provided by the program office and contractors. For FY 1970 and beyond, we used the PA&E estimate in

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[4] Karen Tyson et al., "The Effects of Management Initiatives on the Costs and Schedules of Defense Acquisition Programs, Vol. I: Main Report," IDA Paper P-2722 (Alexandria, VA: Institute for Defense Analyses, 1992).

[5] Jeanne M. Jarvaise, Jeffrey A. Drezner, and Dan Norton, "The Defense System Cost Performance Database: Cost Growth Using Selected Acquisition Reports," RAND Report MR-625-OSD (Santa Monica, CA: The RAND Corporation, 1996).

all cases in which the last SAR for the program had been filed by the time of the final update of the PA&E database (which used the December 2004 SARs). In a few cases, P-2722 had a cost growth estimate for a program not included in the PA&E database. In these instances, we used the estimate from P-2722 if the program was reported complete in the most recent SARs used in making the estimate; otherwise, we used the RAND estimate if available.

E. Computation of the P-5126 (Main Database) V 5.3 Estimates

This section briefly describes how the 66 in-house estimates were made. The relevant data and computations are in the "Data and Computations for In-house Cost Growth Estimates.xlsx" file on the CD.

1. RDT&E

The SARs report fully configured units acquired with RDT&E funds and those acquired with procurement funds. Only the former are used in computing quantity-adjusted RDT&E cost growth. Our procedure was simply to compute the ratio of the Current Estimate (CE) of RDT&E cost and the baseline RDT&E cost (both in program base year dollars) and scale that by the ratio of baseline quantity to CE quantity. Suppose, for example, that the number of fully configured units purchased with RDT&E funds has increased from four to five and that CE RDT&E cost is 50 percent larger than the baseline cost. Our computation of unit RDT&E cost growth is then (4/5) x 1.5 - 1, or 20 percent.

2. APUC

The method used to normalize APUC for quantity change depended, first, on the extent to which quantity changed between MS B and the final SAR and, second, on whether a useable estimate of the slope of the learning curve was available.

a. No Quantity Change (NQC)

The SAR CE quantity was within ±1 percent of the MS B quantity for 12 of the MDAPs for which estimates were required. No quantity normalization is needed for these programs; their APUC growth is computed by dividing the CE APUC in the final SAR (or the December 2012 SAR for an ongoing program) by the MS B APUC and subtracting 1. The APUC growth for SBIRS-High also falls under this heading. The total number of SBIRS-High satellites to be acquired decreased from five (at MS B) to four (the December 2012 SAR). The decrease, however, was in a satellite purchased with RDT&E funds, and we did not put these on a learning curve. There was no change in the number of SBIRS-High satellites purchased with procurement funds. Finally, although

the PAC-3 quantity change fell outside the ±1 percent boundary, data limitations made it necessary to compute the PAC-3 APUC growth as the ratio of the CE and MS II APUCs.

b. Defense Acquisition Management Information Retrieval System (DAMIRS) Learning Curve (DLC)

The DoD contractor staff for DAMIRS provided us with their estimates of learning curve parameters that we were able to use to compute APUC growth for 13 MDAPs that passed MS B during FY 1989–FY 2001. We refer to these as the DAMIRS Learning Curve (DLC) APUC growth estimates. For each of these, we took the CE APUC growth in program base year dollars from the last SAR for the program or the December 2015 SAR (for ongoing programs). The task was to normalize this APUC estimate to the MS B quantity, which was done as follows:

- We used the learning curve to compute the recurring flyaway cost at the MS B baseline quantity.
- The CE estimates of RDT&E and non-recurring flyaway cost were taken from the final SAR for the program or from the December 2012 SAR (for ongoing programs).
- Support costs paid for with procurement dollars are, for many programs, primarily initial spares and support equipment, although other items may also fall into this category. Initial spares and support equipment normally scale with the number of units of the system purchased. For that reason, we used the CE support cost reported in the last or most recent SAR scaled to the MS B baseline quantity.

c. Calibrated Learning Curve (CLC)

Twenty-nine MDAPs did not have a PA&E estimate or estimated learning curve parameters, and their CE quantity was significantly different from the MS B quantity. The approach we used in those cases rested on a cost progress curve of the conventional form:

$$C = TQ^{\beta}. \tag{B-1}$$

In this expression, C is recurring flyaway cost, T is first unit cost, Q is cumulative production, and β is the cost progress parameter. We solved this and used the CE for recurring flyaway to get:

$$\hat{T} = CQ^{-\beta}. \tag{B-2}$$

This will be referred to as the calibrated learning curve (CLC) method. A value of $\beta = 0.94$ was used for each of the programs. From this point, the computations were the same as those for MDAPs for which DAMIRS staff provided the learning curve parameters.

3. PAUC

Quantity PAUC is simply the sum of quantity normalized RDT&E and procurement, divided by the baseline quantity, less 1. The baseline quantity includes both units bought with RDT&E funds and those bought with procurement funds.

4. Summary

Table B-3 provides an overview of the number of estimates in P-5126 made with each of the methods.

Table B-3. Sources of the Quantity Normalized Unit Cost Growth Estimates Used in Different Periods

Period (FY)	NQC	DLC	CLC	Total
1989–2001	5	13	21	39
2002–2010	7	0	20	27
Total	**12**	**13**	**41**	**66**

F. Comparison of the PA&E and CLC/DLC PAUC Growth Estimates

P-5126 compared the PA&E estimates for 23 MDAPs with estimates made using the CLC and DLC methods.[6] That material is repeated here without substantial changes.

The obvious approach is to compare the PA&E PAUC growth for systems that have been completed with PAUC growth for those same systems computed using the DLC and CLC methods. Unfortunately, there are no MDAPs that have been completed and for which we have both a PA&E PAUC growth estimate and the data needed to compute a DLC or CLC estimate. The best we can do is to examine the 23 MDAPs that passed MS II/B during FY 1989–FY 2001 and for which we have a PA&E PAUC growth estimate, a DLC estimate, and a CLC estimate.

The PA&E estimates were most recently updated with the 2004 SARs. The DLC and CLC estimates, in contrast, incorporated more recent data—either the final SAR for the program or, for ongoing programs, the December 2012 SAR. Consequently, in most cases we would expect the DLC and CLC PAUC growth estimates to be larger than the

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6 McNicol and Wu, "Evidence on the Effect of DoD Acquisition Policy and Process," A-7, A-9.

corresponding PA&E estimate. That is the test: A method fails if it yields estimates that are "too often" and by "too much" less than the PA&E estimates. Clearly, this is a weak test.

The relevant estimates are presented in Table B-4. The comparison of the PA&E estimates and CLC estimates is on the left, and the comparison of the PA&E and DLC estimates is on the right. The CLC estimates are larger than the PA&E estimates for 17 of the 23 MDAPs—in most cases, considerably larger. They are smaller in six cases (shaded rows). In all but one of these cases (Joint Direct Attack Munition, or JDAM) the differences are absolutely or relatively small. The average of CLC PAUC growth estimates is 77 percent, in comparison to an average of 60 percent for the PA&E estimates. The DLC estimates exhibit the same pattern. The average of the DLC estimates is 73 percent, and four of them (shaded rows) are less than the PA&E estimate for the program, three by a substantial amount.

Table B-4. Comparison of PA&E, CLC, and DLC PAUC Growth Estimates for 23 MDAPs

Program	PA&E	CLC	Program	PA&E	DLC
Longbow Apache	78%	117%	Longbow Apache	78%	133%
F-22	41%	71%	F-22	41%	55%
F/A-18E/F	6%	12%	F/A-18E/F	6%	9%
Bradley Upgrade	39%	54%	Bradley Upgrade	39%	86%
MIDS	30%	72%	MIDS	30%	68%
CEC	48%	62%	CEC	48%	62%
H-1 Upgrades	124%	192%	H-1 Upgrades	124%	197%
LPD 17	43%	71%	LPD 17	43%	72%
CH-47F	147%	173%	CH-47F	147%	156%
GMLRS/GMLRS AW	125%	249%	GMLRS/GMLRS AW	125%	243%
MH-60S	62%	69%	MH-60S	62%	70%
Tactical Tomahawk	24%	28%	Tactical Tomahawk	24%	27%
GBS	10%	31%	GBS	10%	33%
Stryker	21%	25%	Stryker	21%	22%
UH-60M Black Hawk	49%	62%	UH-60M Black Hawk	49%	61%
WGS	28%	55%	WGS	28%	42%
C-130J	70%	84%	C-130J	70%	70%
JPATS	43%	40%	JPATS	43%	44%
SSN 774	35%	33%	SSN 774	35%	37%
JDAM	18%	-10%	JDAM	18%	-13%
Javelin	229%	197%	Javelin	229%	134%
MH-60R	95%	74%	MH-60R	95%	80%
NAS	25%	21%	NAS	25%	1%
Average	**60%**	**77%**		**60%**	**73%**

Note: The PA&E estimates were updated only through the 2004 SARs. The CLC and DLC estimates incorporate information from the last SAR for the program or the December 2012 SAR (for ongoing programs).

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References

Adams, Gordon, Paul Murphy, and William Grey Rosenau. *Controlling Weapons Costs: Can Pentagon Reforms Work?* New York: Council on Economic Priorities, 1983.

Augustine, Norman R. *Augustine's Laws*. Revised and expanded edition. New York: Viking, 1986.

Borklund, C. W. *The Department of Defense*. New York: Frederick A. Praeger, 1969.

Department of Defense Directive (DoDD) 3200.9, Initiation of Engineering and Operational Systems Development, February 26, 1964.

DoDD 3200.9, *Initiation of Engineering and Operational Systems Development*, July 1, 1965 (revised).

DoDD 5000.1, *The Defense Acquisition System*, May 12, 2003.

Department of Defense Instruction (DoDI) 5000.2, *Operation of the Defense Acquisition System*, May 12, 2003.

Fox, J. Ronald. *Defense Acquisition Reform, 1969 to 2009: An Elusive Goal*. Washington, DC: U.S. Army Center of Military History, 2011.

Glennan, Thomas K., Jr. "Policies for Military Research and Development." RAND Paper P-3253. Santa Monica CA: The RAND Corporation, 1966. https://www.rand.org/content/dam/rand/pubs/papers/2009/P3253.pdf.

Jarvaise, Jeanne M., Jeffrey A. Drezner, and Dan Norton. "The Defense System Cost Performance Database: Cost Growth Using Selected Acquisition Reports." RAND Report MR-625-OSD. Santa Monica, CA: The RAND Corporation, 1996.

Jones, Frank L. *A "Hollow Army" Reappraised: President Carter, Defense Budgets, and the Politics of Military Readiness*. Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2012.

Kim, Yool, Elliot Axelband, Abby Doll, Mel Eisman, Myron Hura, Edward G. Keating, Martin C. Libicki, Bradley Martin, Michael E. McMahon, Jerry M. Sollinger, Erin York, Mark V. Arena, Irv Blickstein, and William Shelton. "Acquisition of Space Systems: Past Problems and Future Challenges." RAND MG-1171/7-OSD. Santa Monica CA: The RAND Corporation, 2015.

Krepinevich, Andrew. "What Would Jimmy Carter Do?" http://www.defenseone.com /ideas/2014/03/What Would Jimmy Carter-do-Defense-One.htm.

McCrillis, John. "Cost Growth of Major Defense Programs." Briefing. Presented at Department of Defense Cost Analysis Symposium, Williamsburg, VA, January 30, 2003.

McNicol, David L. *Cost Growth in Major Weapon Procurement Programs*. 2nd ed. Alexandria, VA: Institute for Defense Analyses, 2004.

McNicol, David L., Sarah K. Burns, and Linda Wu. "Evidence on the Effect of DoD Acquisition Policy and Process and Funding Climate on Cancellation of Major Defense Acquisition Programs." IDA Paper P-5218. Alexandria, VA: Institute for Defense Analyses, May 2015.

McNicol, David L., David M. Tate, Sarah K. Burns, and Linda Wu. "Further Evidence on the Effect of Acquisition Policy on Cost Growth of Major Defense Acquisition Programs." IDA Paper P-5330 (Revised). Alexandria, VA: Institute for Defense Analyses, August 2016.

McNicol, David L., and Linda Wu. "Evidence on the Effect of DoD Acquisition Policy and Process on Cost Growth of Major Defense Acquisition Programs." IDA Paper P-5126. Alexandria, VA: Institute for Defense Analyses, September 2014.

Murdock, Clark A. *Defense Policy Formation*. Albany, NY: State University of New York Press, 1974.

O'Neil, William D., and Gene H. Porter. "What to Buy? The Role of Director of Defense Research and Engineering (DDR&E)—Lessons from the 1970s." IDA Paper P-4675. Alexandria, VA: Institute for Defense Analyses, January 2011.

Porter, Gene, Brian Gladstone C. Vance Gordon Nicholas Karvonides R. Royce Kneece, Jr. Jay Mandelbaum, and William D. O'Neil. "The Major Causes of Cost Growth in Defense Acquisition: Volume I-Executive Summary." IDA Paper P-4513. Alexandria, VA: Institute for Defense Analyses, December 2009.

Selected Acquisition Report: Global Broadcast System. Defense Acquisition Management Information Retrieval (DAMIR). December 2003.

Srull, Donald, ed. *The Cost Analysis Improvement Group: A History*. McLean, VA: Logistics Management Institute (now LMI), 1998.

Tyson, Karen W., Neang I. Om, D. Calvin Gogerty, and J. Richard Nelson. "The Effects of Management Initiatives on the Costs and Schedules of Defense Acquisition Programs, Vol. I: Main Report." IDA Paper P-2722. Alexandria, VA: Institute for Defense Analyses, 1992.

United States Department of Defense, Office of the Under Secretary of Defense (Comptroller). *National Defense Budget Estimates for FY 2014*. Washington, DC: Department of Defense, May 2013.

Whittle, James R. *The Dream Machine*. New York: Simon and Schuster, 2010.

Younossi, Obaid, Mark A. Lorell, Kevin Brancato, Cynthia R. Cook, Mel Eisman, Bernard Fox, John C. Graser, Yool Kim, Robert S. Leonard, Shari Lawrence Pfleeger, and Jerry M. Sollinger. "Improving the Cost Estimation of Space Systems: Past Lessons and Future Recommendations." MG-690-AF. Santa Monica, CA: The RAND Corporation, 2008.

Abbreviations

ACAT	Acquisition Category
A-D	Anderson-Darling Test
AHIP	Army Helicopter Improvement Program
ANOVA	Analysis of Variance
APUC	Average Procurement Unit Cost
AR	Acquisition Reform
ATM	Asynchronous Transfer Mode
BA	Budget Authority
CAIG	Cost Analysis Improvement Group
CAPE	Cost Assessment and Program Evaluation
CD	Compact Disc
CE	Current Estimate
CLC	Calibrated Learning Curve
CPIF	Cost Plus Incentive Fee
CY	Calendar Year
DAB	Defense Acquisition Board
DAMIR	Defense Acquisition Management Information Retrieval
DCP	Development Concept Paper/Decision Coordinating Paper
DDR&E	Director, Defense Research and Engineering
DLC	DAMIRS Learning Curve
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instruction
DSARC	Defense Systems Acquisition Review Council
EMD	Engineering and Manufacturing Development
FET	Fisher's Exact Test
FFP	Firm Fixed Price
FPIF	Fixed Price Incentive Fee
FY	Fiscal Year
GBS	Global Broadcast System
GRH	Gramm-Rudman-Hollings

IDA	Institute for Defense Analyses
IFF	Iraqi Freedom Funds
IP	Internet Protocol
JDAM	Joint Direct Attack Munition
K-S	Kolmogorov-Smirnov Test
MAIS	Major Automated Information System
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MILPERS	Military Personnel
MS	Milestone
M-W U	Mann-Whitney U Test
NQC	No Quantity Change
O&M	Operations and Maintenance
OASD(SA)	Office of the Assistant Secretary of Defense for Systems Analysis
OLS	Ordinary Least Squares
OSA	Office of Systems Analysis
OSD	Office of the Secretary of Defense
PA&E	Program Analysis and Evaluation
PAUC	Program Acquisition Unit Cost
P-C	Post-Carlucci
PPBS	Planning, Programming, and Budgeting System
RDT&E	Research, Development, Test and Evaluation
SAR	Selected Acquisition Report
SBIRS-High	Space-Based Infrared Satellite-High
TPP	Total Package Procurement
US	United States
USD(AT&L)	Under Secretary of Defense (Acquisition, Technology and Logistics)
VCJCS	Vice Chairman, Joint Chiefs of Staff
WSARA	Weapon Systems Acquisition Reform Act of 2009

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14. ABSTRACT

A previous paper in this series examined whether changes in acquisition policy and funding climate had statistically discernible associations with cancellations of Major Defense Acquisition Programs (MDAPs). It did not provide any statistical analysis of truncations —that is, MDAPs that bought fewer units of a system than was intended at Milestone (MS) B. This paper extends the earlier one; it provides parallel analyses of both cancellations and truncations, has more observations (especially on truncations), and provides an improved analysis of cancellations. The paper finds that cancellations of MDAPs are concentrated in the two periods during which DoD procurement funding was declining, often sharply. With one possible exception, cancellations and truncations are (1) not associated with the acquisition policy and process configuration in place when they passed MS B, given funding climate; and (2) not consistently associated with the funding climate prevailing at MS B, given the acquisition policy and process configuration. The paper also finds that, while cancelled programs on average had higher cost growth than programs not cancelled, most programs with unit cost growth of more than 50 percent were not cancelled.

15. SUBJECT TERMS

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